BROOKLYN BOTANIC GARDEN

PLANTS & GARDENS

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THE HOME LAWN HANDBOOK

HOW TO

- Control Crab Grass & Other Weeds
- Build a New Lawn from Seed or Sod
- Control Pests & Diseases
- Grow Grass in Shade and On a Slope
- Overseed a Winter Lawn
- Control Thatch

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Copies of special issues of PLANTS & GARDENS are available as Handbooks. For a list of topics see back cover.

V. Gibeault *George Taloumis*

Left: This lawn, of warm-season grasses that go dormant in cool weather, has just been dethatched and overseeded (see page 74). *Right:* This brick edging, called a mowing strip, lowers maintenance time by eliminating hand trimming.

Rutgers University

This grass sample shows a severe thatch condition. (See page 48.) The thatch layer consists of the dark dense area between the top growth and light colored soil.

LETTER FROM THE BROOKLYN BOTANIC GARDEN

A well-groomed lawn, bright green, uniformly dense and refreshingly cool on a hot summer day, is one of the real pleasures of outdoor living. Clearly, although lawns have been known since ancient Persian times, an increasing number of people are sharing in this pleasure these days. One of our Contributors, James B. Beard, in his recent textbook TURFGRASS: SCIENCE AND CULTURE (Prentice-Hall, Inc., Englewood Cliffs, N.J.), mentions that probably more than 20 million acres are devoted to turf in the United States today. Turf maintenance alone amounts to over $4.3 billion dollars a year.

Not surprisingly in view of the importance that Americans attach to the outdoor carpet of greenery, lawn care has become a rather precise science. Much has happened in the world of turf grass since the Botanic Garden's last issue on the subject seventeen years ago, so the time for a brand new Handbook is opportune. Let us thank Guest Editor Henry W. Indyk of Rutgers University and his blue ribbon panel of lawn experts from around the country for bringing us up-to-date.

It is interesting that nearly all of our lawn grasses come from other lands. Even "Kentucky" bluegrass, the grass that northern home owners know the best, had its origins in Europe. Another of our Contributors, Robert W. Schery, in his newly revised book A PERFECT LAWN THE EASY WAY (Macmillan Publishing Co., New York), suggests that bluegrass came to Kentucky through the St. Lawrence Valley, courtesy of French missionaries who distributed seeds to the Indians. It took root and spread in the phosphatic soils around what is now Lexington. In any event, parts of Kentucky were a sea of bluegrass long before Daniel Boone arrived upon the scene.

Lawn grasses, it might be pointed out, form only one part of the large grass family. Wheat, rice and maize (Indian corn) are members too and, in fact, have nurtured great civilizations. The Eastern Parkway gate to the Botanic Garden has as its central theme these three grasses. If you happen to visit the Garden, please let this be a cordial invitation to pause and look at this symbolic entryway before wandering through the collection of 12,000 kinds of living plants here.

May this Handbook make lawn care easier and more enjoyable for you.

Frederick McGourty, Jr.

Editor

A NEW LAWN—STEP-BY-STEP

Robert W. Schery

PLANTING a new lawn is not a complicated procedure, but it does require a well-thought-out set of steps to be fully successful. In sequence the steps are: soil preparation (preferably cultivation); fertilization; leveling and refining; seeding (or sodding, sprigging or plugging); mulching; and watering.

For northern lawns, which are generally seeded, a late August-September sowing is advantageous. The fine turf grasses normally used in the North—the bentgrasses, Kentucky bluegrasses, fine fescues, and perennial ryegrasses—grow best when days are warm but nights cool. They sprout most rapidly when the soil is warm from summer's residual heat, rather than cold as in spring.

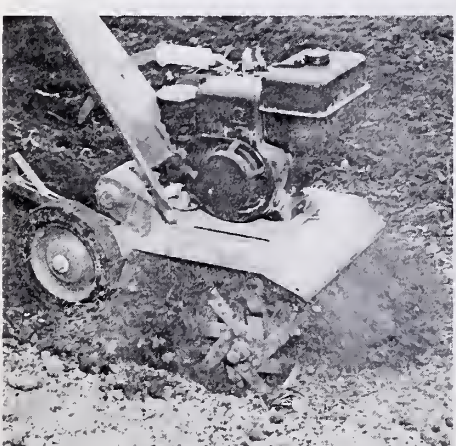
Other advantages to an autumn sowing are the decline of weed growth in that season, the shortening days and increasingly crisp weather (which reduces the need for watering), and the nature of cool-season grass physiology (which makes for greater food gain in cool weather than in hot). Next best after autumn for sowing lawns is early spring, while least desirable is summer, except for extremely high altitudes and latitudes, where summer is cool and short.

In the southern United States, where vegetative plantings are more commonplace than in the North, lawn planting is best undertaken in spring and early summer. The species which grow there (Bahia, Bermuda, centipede, St. Augustine, zoysia) do best in warm weather.

The choice of lawn seed (or vegetative cultivar) is especially critical. (See also page 61.) In general, seed blends that contain improved, named varieties ('Baron', 'Fylking', 'Merion', 'Nugget' and 'Sodco' bluegrasses; 'Highlight', 'Jamestown' and 'Ruby' fescues; for example) represent a worthwhile value, for these varieties were bred and selected to provide superior performance in a tended lawn. They are generally disease-tolerant, low-growing and dense.

A mixture of a few similar varieties is usually preferable to planting a single strain, in order to "spread the risk." A single variety may not prove suitable for all microclimates of the lawn; or should some affliction arise there is no back-up grass when a single strain is smitten. ◆

Lawn Institute



1. The best seedbeds generally are cultivated, although a new lawn can be started merely by scratching the soil surface. Large lawns are typically plowed and disced with agricultural equipment, but a rotary tiller is quite suitable for cultivating small lawns or reworking larger seedbeds. In autumn the soil can usually be readily cultivated, being dry enough to crumble. Some soils take a long time to dry out in spring before they can be cultivated without forming clods.

2. *Left:* The lawn was plowed and disced. Debris and chunks of old sod are being raked up. 3. Fertilizer can be applied at this time (*right*), or can be spread ahead of cultivation if the need is for deeply placed nutrients. However, don't spread fertilizer before major grading operations are complete, lest the bulldozer pile fertilized soil in some places and leave others devoid of nutrients.

4. *Left:* Making a final soil leveling before sowing seed. If fluffy spots are suspected, which may settle into depressions, soak the ground and re-level. A seedbed can be given final touches with a hand rake, as pictured, or more quickly with powered equipment such as a tractor-drawn drag. 5. *Right:* Good lawn-seed blends containing mostly bluegrass and fescue are typically sown about 3 pounds to the 1,000 square feet. Of course, seed can be distributed by hand. Cast half of it while walking in one direction, the other half crosswise to insure against misses. However, seeding is more easily and accurately accomplished with a lawn spreader as at right. A chunky seedbed surface is preferable to a dusty one. Seed settles nicely into the cracks between chunks, becoming buried just enough for good germination. If lawn seed remains on the surface, rake the soilbed lightly or pull a drag across it, tumbling the soil so as to bury most of the seed within the top half inch.

6. Quicker sprouting can be gained if a mulch is used. Damp peat moss (*above*) is being scattered over a seedbed. Peat moss is not necessarily the most suitable mulch since it can "float" off in heavy rain, but it is one that is readily procurable. In rural areas, clean straw—straw devoid of weed or grain seeds—may still be obtainable. Most garden centers stock woven nettings, excelsior mats or similar man-made mulching materials.

7. This lawn has been mulched with straw. A perforated hose is being used for watering. Visible germination takes about two weeks in warm soil, a bit longer on cooler ground. Unmulched lawns may need watering daily—depending upon how hot and dry the weather is. There is no substitute for regular watering to germinate a new seeding rapidly. Soak the seedbed initially, then water lightly thereafter—enough to keep the soil moist, but not so heavily as to create surface runoff.

8. Within a few weeks green grass should look like the grass above. Most mulches can be left in place to decay, and they will soon be overtopped by the expanding grass. As the grass grows taller and its roots reach deeper, watering can become less frequent. Start mowing when the grass is about twice as tall as will be its eventual mowing height (usually about 1 ½ inches for bluegrass-fescue), letting the soil dry out sufficiently before mowing.

Each seed can be thought of as potential grass shoots if the seed is properly planted

BUYING LAWN SEED

Robert W. Schery

FOR his money's worth, a lawn-seed buyer should be concerned that the seed will sprout, be true to type and be free from unreasonable amounts of dust, chaff, diluents, or weed and crop seeds. The package label carries much information relating to quality of the contents, but proper formulation for local growing conditions and genetic identity of varieties (cultivars) is more a matter of good faith, suggesting purchase from a responsible supplier.

Seed Count and Germination

The actual number of seeds in a package varies according to the kind of grass. Kentucky bluegrass varieties generally have 1.2-2.4 million seeds to the pound, fine fescues 0.5-0.7 million, ryegrasses about 0.2-0.3 million, bentgrass 5-7 million, and common Bermuda grass 1.4-1.8 million. On the label, these differences are compensated for in recommended seeding rates, with due consideration for grass growth habits. Thus, seed count need not be of great concern to the average seed buyer. It will be adequate so long as nearly pure seed is purchased, not deliberately extended with diluents such as ground corncobs, sand or similar material.

It is normal for some kinds of seed to carry as much as 15 percent *inert* material—chaff and the likes. This causes no harm but if the percentage is appreciable, the package should have a lower price. If a seed offering exhibits only 85 percent *purity*, then 15 percent of each pound is useless for providing grass plants. Purity percentage figures are required on the label where they can be checked by the buyer to be sure he is getting the mixture he needs.

Germination (i.e., the percentage of seeds that sprout in good fashion) is also a required listing on the label, and can be easily checked. As with purity, germination will vary somewhat according to the kind of seed. Dead seed that will not germinate is of no value, and a low germination represents a lesser value than a high one. But, by-and-large, a seed purchaser need have no fear about lawn seed germination, since low-germinating products cannot compete in the marketplace. Germination claims are subject to official check, and it is unlikely that any seed house would deliberately claim germination that could not be substantiated by laboratory test.

Weeds

Weeds are, of course, something to worry about, since not only do they dilute the seed but introduce an added nuisance. A very small content of weed seeds can often be a serious problem. However, most noxious weeds, which are the worst agricultural pests, are prohibited or highly restricted by state seed laws, and lawn seed seldom contains them. Also, other weeds are rather well cleaned out of seed offered on the retail market, these days, for competitive reasons. No firm wants a label showing appreciable weed content. Finally, many of the species that are "weeds" according to state law are not a serious problem in the lawn because: a) they cannot survive under mowing, b) although a pest in cultivated fields, they are normally squeezed out by lawn grass, or c) they are easily controlled by modern-day herbicides, such as 2,4-D.

Crop is a catch-all term for foreign non-weed seeds carried in lawn seed. They are mostly forage or field crop species. Crop can become even more troublesome in the lawn than weeds, depending on kind and climate. (The Federal Seed Act requires that any species in a mixture

Rutgers University

The best lawn grasses generally have few seedheads—those stems which are wiry and hard to mow in late spring.

Lawn Institute

The left half of this grass area shows unattractive turf from a seed mixture which included coarse components.

in excess of 5 percent must be listed by species.) Coarse perennial grasses are the worst crop offenders—species like tall fescue, orchard grass, timothy, and brome grass. These can be real pests in the lawn, for there are no selective herbicides to free the lawn of them later.

Yet, sometimes, appreciable crop is of little consequence, as with common bluegrass in 'Merion'. The common blue grass scarcely will be distinguishable from the 'Merion', and will probably be squeezed out quickly by the more vigorous 'Merion'. In other cases the seriousness of inadvertent grass inclusions will depend upon local circumstances. Slight bentgrass contamination of bluegrass is of no consequence where bentgrass is already adventive, but it may be a pest in bentgrass-free plantings such as bluegrass sod producers try to maintain. Most lawn seed houses try to offer seed that is not contaminated with serious crop.

Formulation

Perhaps the inexperienced home owner's most serious concern is lawn-seed *formulation.* Formulation involves blending of grasses appropriate to local climate and particular use. Formulation is much a matter of judgment, and will vary from region to region. But, in general, seed should include varieties of permanent value (perennial for the climate), that are attractive (i.e. fine-textured), and at least in part able to spread and colonize vacant ground (i.e. be rhizomatous or stoloniferous).

Responsible houses generally offer seed suited to the area, but a buyer had best be informed enough to know which kinds of grasses are "good" ones for permanent lawns of his area and under the level of care he expects to provide. A seller cannot be blamed if seed inappropriate to a particular circumstance is chosen, so long as it is not misrepresented. For example, bentgrass provides high quality turf when properly tended, but many homeowners are unable to give bentgrass the care it needs to perform well. This is a matter of choice and not faulty formulation. Or, if an inexpensive seed package is clearly labeled to be mostly annual ryegrass, even though this grass is short-lived and impermanent, the purchaser must take the responsibility for its choice over a better quality blend consisting of Kentucky bluegrasses, fine fescues and perennial ryegrasses. ◆

A fine lawn requires careful attention to soil improvement as well as maintenance.

A lawn can be no better than the soil in which its roots have to grow

THE LAWN AND ITS SOIL

R. B. Alderfer

TO understand the reasons for the importance of the soil in building a lawn, one should know what things grass must get from the soil. Lawn grasses, like other green plants, depend upon the soil to supply their roots with air, water, and nutrients. A good or poor job of lawn building can be judged on how well these conditions are met.

First, consider the matter of air supply; why is it important and what can one do to insure a properly aerated or well ventilated soil? Like all living things, plant roots must have oxygen. While they do not inhale and exhale—the breathing process of animals—they do absorb oxygen and give off carbon dioxide. This respiratory activity is of top importance because the uptake of nutrients and water by plant roots *is directly controlled* by their rate of respiration. Thus aeration is the key to soil productivity.

Most living things can survive without food for many days but without water, oxygen or with too much carbon dioxide they will die in a matter of minutes. Therefore, plants must have a constant supply of fresh air from the atmosphere flowing to the surface of every living and growing root to replace the stale carbon dioxide-laden air which constantly is building up around these roots. This exchange of air to and from the soil takes place through the spaces or openings between the solid particles of the soil.

Soil Spaces

Every soil has two kinds of spaces. The larger spaces between soil particles serve as the air spaces through which a soil "breathes." It is through these large openings that rain or irrigation water runs into the soil and is distributed to the

smaller or capillary spaces. These are the spaces in which water is held in the soil.

The Ideal Soil for Turf Grass

An ideal soil has 50% solid matter, 25% to 30% small pores or water space, and 20% to 25% large pores or air space. Heavy, wet, clay soils often have too little air space, while very sandy soils have too few small water-holding pores.

The size and character of soil pores may be changed by compaction. In building a lawn avoid running heavy machinery over it, especially when the soil is wet. This compacts the soil to the point where the percentage of air space is greatly reduced. In working the soil into condition for seeding avoid reducing it down to a fine powder. At least 50% of the soil can remain in the form of crumbs or granules with diameters of 1/16 to ⅛ of an inch. This will provide enough large openings for good aeration.

Good Drainage is Essential

Adequate drainage is essential for good turf. Poor drainage in a soil is bad because too many of the pores stay filled with water too long. Plant roots will not grow into water-saturated layers. Roots which have grown into soil which is periodically saturated by a fluctuating water table soon die from lack of oxygen due to poor aeration. A poorly drained layer of soil can be detected by its mottled red-yellow-blue and gray color. Wet soil conditions can be caused by poor surface drainage in which water from rainfall or irrigation collects in a low spot on the lawn. This often can be prevented by gently sloping the lawn away from the house, toward a place where water from very heavy rains that the soil cannot absorb will run off safely, such as a paved street, gutter, or woods. Firm, but do not compact, the subgrade as well as the finished surface grade to avoid an uneven surface caused by unequal settling of the soil after the lawn is established.

Presence of a high water table or a flow of seepage water near the surface is a second cause for wet soils. Tile drainage is the best means of intercepting and disposing of water from one of these sources. If such drainage seems to be needed, one should get the advice of a qualified person to help with the design and installation of a tile drainage system. A suitable place to outlet the water from the tile drains is an absolute must.

Wet soils also may be due to the presence of a tight impervious layer in the subsoil. If this layer is thin enough and can be reached it may be ripped with a deep tillage implement and treated with gypsum, 10 pounds per 100 square feet. If the layer is thick and deep the only practical thing to do is to try to provide as favorable conditions as possible in a 6- to 8-inch layer of surface soil.

What is Good Topsoil?

Good quality topsoil has sufficient organic matter in it to give it the tilth, aeration, and water-holding capacity that will make lawn establishment easy. Topsoil quality is to be judged chiefly by its ability to provide good aeration and water-holding capacity but not so much on its fertility. Fertility can be added by proper liming and fertilization. The following specifications for good quality topsoil hold for that which you have on your property or that which you buy.

Texture. Good topsoil should be neither too sandy nor too clayey. It should be loamy in texture. You can identify a loam by taking a handful of moist soil and making a ribbon of it by forcing it out between your thumb and forefinger. If the ribbon breaks off every inch or so after passing your forefinger, the soil is a loam. The ribbon formed by a too sandy soil will break apart right after it leaves your fingers while a heavy clay will form a ribbon of 3 or more inches before breaking. The texture of topsoil can be determined more accurately by sending it to a soil testing laboratory.

Organic Matter Content Good quality topsoil should have at least 2% organic matter. While a laboratory test for organic matter is the best, most soils with this percentage of organic matter will be medium to dark brown in color when moist.

Tilth Good tilth can be determined by seeing how easily the larger lumps break into or can be worked into well-defined crumbs or granules 1/16 to ⅛ inch in diameter. Place a handful of topsoil in a jar filled with water and see how much of it slakes down into a fine mud. No more than 50% of the soil should slake down into particles smaller than 1/16 to ⅛ inch in diameter.

Fertility and Weediness The fertility and weediness of topsoil often can be estimated by knowing what the land had been used for before you acquired it. If it had been good farm land from which the topsoil had not been removed, one that such a person as your county agricultural agent would vouch for, it will likely be fairly fertile and free of too many perennial weed seeds. Topsoil of the right texture and organic matter content from idle land should not be rejected because of low fertility or weediness. Use of the proper amount of lime, fertilizer, and herbicide will take care of these two problems. The best way to learn the fertility and the acidity or alkalinity of the soil is to have it analyzed by a reputable soil testing laboratory.*

Stock Pile Topsoil

If the land on which the lawn is to be established has a topsoil layer, scrape it off the building area into a pile before digging the foundation. Use the best quality subsoil from the foundation for backfilling around the outside walls and for building up low spots from which the topsoil first has been removed. On land that has a large number of stones, boulders, or rock ledges very close to the surface, remove as many of them as possible so as to allow 6 to 8 inches or more of topsoil to remain over them after final grading. Areas with only 2 or 3 inches of soil over a rock layer will never grow good turf.

Waste materials used in building, such as plaster, bricks, boards, etc., should not be buried in the soil, but hauled away.

Improving Poor Quality Soil

The amount of moisture which is available to plant roots that a soil can hold is determined by its texture, aeration and organic matter. A sandy soil generally has sufficient aeration but low water-holding capacity. This is because it has too few small water-holding pores but generally plenty of large air spaces or noncapillary pores. Just the opposite is true for a clay soil. Organic matter is the universal soil-conditioning material used to improve the water-holding capacity of sandy soils and the aeration of clay soils. Improving the aeration of clay soils enables plant roots to use the large amount of water which such soils are capable of absorbing and holding. With the proper use of organic matter, land without good surface soil can be made to produce a good lawn.

Organic matter in the form of cultivated peat, peat moss, well-rotted manure, fine sewage sludge and spent mushroom soil can be applied at the rate of 1 to 2 pounds per square foot or 1 to 3 cubic yards per 1000 square feet. It should be thoroughly mixed with the first 6 or 8 inches of soil. There are a number of other waste materials which can be used as a source of organic matter but a soil or turf-grass specialist should be consulted about them.

Improving Water-holding Capacity

The water-holding capacity of very sandy soils can be increased by applying a 1- to 2-inch layer of clay loam and mixing it to a depth of 5 or 6 inches. It is more of a task to loosen a heavy clay loam by mixing sand with it. A 6-inch layer of sandy loam or 3 to 4 inches (1-1½ tons per 100 square feet) of pure sand is required to improve the aeration of a 6-inch layer of heavy clay soil.

Turf grass should have at least a foot of well-aerated soil into which its roots can grow and absorb water. Good turf can be grown with less soil, but moisture problems increase in proportion as depth

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* See p. 20 of the BOTANIC GARDEN HANDBOOK ON SOILS for list of such laboratories.

of soil decreases.

The available supply of nutrients in the soil is regulated by its acidity or alkalinity and the fertility level. The only sure way of learning what these conditions are in a soil is to have it tested. This is particularly important with regard to acidity and alkalinity. Most soils in the eastern United States are naturally acid or tend to become acid if they are not limed regularly. While a test is best, the general recommendation of 50 pounds of hydrated lime or 75 pounds of limestone for each 1000 square feet will adjust the acidity or pH of quite a few soils to near the desired level. All liming materials should be thoroughly mixed with the soil to a depth of 6 or 8 inches as long before fertilization as possible.

(For kinds of fertilizers to use and rates of application, see pages 13-16) ♦

Soil Tests in Lawn Fertilization

MANY county agricultural agents have facilities for making quick soil tests and there are inexpensive soil test kits on the market. The ones for testing soil alkalinity or acidity (soil reaction) are satisfactory provided instructions are followed. Some of the kits for other quick soil tests are also satisfactory, but the best way is to send samples to a responsible laboratory manned by trained personnel, where reagents are kept fresh at all times and turf grass agronomists interpret the results. The agricultural experiment stations in most states have soil-testing laboratories (see *Botanic Garden Handbook* on *Soils*, pp. 20-23).

To obtain consistent results, it is necessary to take samples to *exactly the same depth at all times*. The amounts of phosphorus and potash decrease sharply with depth on grassy areas because the soil is not disturbed after turf coverage is obtained. Failure to appreciate this fact has been responsible for misleading results even with the better soil-testing methods. This is the reason for specifying a standard 2-inch depth of sampling.

Variations in soil, topography, and turf determine the number of composite samples to collect. On level areas of uniform soil, four to six composite samples suffice. Each should consist of four to six cores of uniform diameter and be exactly 2 inches long. They should be taken from widely separated spots on the lawn. When sampling a localized area of poor turf, collect another sample from a nearby spot of good grass. Include information about drainage, kind of grass, maintenance, watering, and fertilizer practices.

Each sample should be air dried before placing in a clean, new container for shipment. Label the outside of each sample plainly with a soft lead pencil, giving pertinent information.

Yearly testing is seldom necessary. A test every three to four years is usually satisfactory.

The important points to remember if a soil test is to provide worthwhile information are:

1. Representative grass areas must be sampled at exactly the same 2-inch depth.
2. Laboratory testing must be done by a method reliable for grassy areas.
3. The results are best interpreted by scientists familiar with the plant food requirements of turf grass.—*C. G. Wilson*

It is a rare soil that contains enough natural fertility to provide for optimum grass growth under lawn management conditions

LAWNS NEED FERTILIZER AND LIME

C. R. Skogley

OF all the requirements of lawn management, the one having the greatest influence on turf grass quality throughout much of the United States is fertilizing.

Living organisms, both animal and plant, require "food" or "nutrients" to survive and flourish. In the case of plants, fertilizer must be considered as the "food" or "nutrient." It is generally necessary to supplement the existing fertility with "plant food" from a bag if dense, green and pleasingly acceptable lawns are to be developed and maintained.

There are about a dozen-and-a half elements or "nutrients" required for plant growth. Most of these elements are sufficiently abundant in the atmosphere or in the soils to meet plant requirements. Three elements, however, that are considered "major" and that are frequently in low supply in our soils are nitrogen, phosphorous and potassium. When a bag of complete lawn or garden fertilizer is purchased at the garden center, these are the three nutrients that will be present.

Nitrogen

Nitrogen, the most important of the three nutrients, provides the color and growth that is so noticeable following a fertilizer application. Large quantities of nitrogen are required during a growing season in order to maintain vigor following repeated cutting with the mower. The nitrogen requirement of lawn grasses exceeds that of most plants because of constant clipping and the great length of season during which the plants are expected to "produce."

Nitrogen is a mobile element—that is, it is able to move up and down in the soil. It is also subject to leaching losses on light soils or under heavy watering. Some nitrogen may also be lost to the atmosphere in the form of gas. Since grass requirements for nitrogen are considerable and since it is a mobile element, it is difficult to maintain constant, uniform supplies in the soil. It is generally necessary to make several applications a season to meet the needs of healthy grass.

Phosphorus

Phosphorus, by contrast, is relatively immobile and moves very slowly in the soil. It tends to be bound to soil particles and, possibly, yearly applications would prove adequate in most cases. This element is particularly important in the establishment of lawns. Ample supplies of phosphorus should be well mixed with the soil when a new lawn is begun. Seed germination, seedling vigor and early root growth seem to be enhanced by ample supplies of phosphorus.

Potassium

Potassium is somewhat of a mystery element in plant nutrition. There is no question that it is needed in considerable quantity but its exact roles have not been fully determined. It does appear to be important in providing hardy, disease-resistant grasses. Potassium is mobile and can move in the soil. A good practice is to apply small amounts two or more times a season.

Aside from calcium and magnesium, which can be supplied through liming, there is seldom a need to apply minor or trace elements. The extremely extensive root system of a grass plant makes it very efficient in extracting most elements that are present in a soil. The three major

elements are the ones most frequently lacking.

Most lawn fertilizers are "complete" fertilizers. They contain nitrogen, phosphorus and potassium. They are sold by "grade," such as 10-6-4, 20-10-5, 5-10-5 and many others. These figures refer to the percentage of nitrogen, phosphorus and potassium, always in that order, contained in the bag.

There are considerable differences in recommendations for amounts and kinds of fertilizer to use for establishment and maintenance of lawns. This is because soils and climates are so variable from one area to another. Ideally, the local recommendations developed within each state should be the most accurate. Whenever possible, soil tests should be used as guides in developing a fertilizer program. This should provide the greatest efficiency.

Fertilizer for a New Lawn

Some general guides for using fertilizer, in the event local recommendations are lacking, can be made. For establishment of a new lawn, a fertilizer high in phosphorus, such as 5-10-5 grade, is commonly used. A rate of about 40 pounds for each 1000 square feet should be well mixed with the upper few inches of soil. The same type of fertilizer might be used, at half the rate, for starting an improvement program on very poor, undernourished lawns.

Established Lawns

The most frequently used fertilizers for maintenance of established lawns are those high in nitrogen. Many different grades are available and suitable. Generally, one pound of nitrogen is recommended for each 1000 square feet for each application. A minimum of two seasonal applications are required and as many as six or eight may be made, depending on soil and climate and the lawn owner's standards. A chart (Table 1) will serve as a guide in determining the quantities of different grades of fertilizer to apply at a single application.

The nitrogen in lawn fertilizers comes in different types. It may be inorganic, natural organic, synthetic organic or combinations of these. Grasses are not particular about the form in which they receive this important nutrient. The main difference is that the more insoluble organic materials are longer-lasting and less likely to scorch the grass if over-applied. Generally, the organic materials must be applied at higher rates. Directions for application are generally on the container.

TABLE 1
Amount of Fertilizer to Apply per 1000 sq. ft. per Application

If Nitrogen % is	Pounds of Fertilizer
5	20
6	17
7	14
8	12
9	11
10	10
12	8
15	7
18	6
20	5
25	4

It is possible to over-fertilize! Light, frequent applications are better than heavy, infrequent ones—unless slow-release materials are used. A faithful, routine program of common-sense fertilizer usage will reward those interested in quality lawns.

Fertilizer Application

The method of application of lawn fertilizers is very important. They are best applied with mechanical spreaders so that the correct rate can be applied in a uniform manner to every square inch of the lawn. Many fertilizer bags show settings for a number of the common types of spreaders. Follow directions carefully as excessive amounts of fertilizers can badly scorch turf and may also cause excessive, undesirable growth. Applications that are too light will not provide the desired results, either.

When possible, fertilizers should be applied to dry turf and then watered in well following application. When using a

standard type of spreader, overlap the wheels to avoid skips. If possible, maintain fairly straight lines when pushing the spreader and always shut the spreader off when making turns.

Broad-cast type spreaders will provide excellent and rapid coverage with less chance for skips than with a standard, drop-type spreader. Suggestions for using this type of spreader generally come with the spreader.

Application of fertilizers in hot weather can be very hazardous. If summer applications are made use only light rates and water in well or use natural or synthetic slow-release fertilizers that will not cause scorch at normal rates.

Combination Products

Lawn fertilizers are frequently formulated in combination with other chemicals such as weed killers, insecticides or even fungicides. Some of these combination products are highly advertised with statements made that the single product will solve all lawn problems. In reality, some combination fertilizer-pesticide products may work well, while others may not. The reason for this is *timing* of application. Generally, there is a fairly specific time when crab grass preventers, broad-leaved weed killers, insecticides or fungicides should be applied and this may not coincide with the best time to apply fertilizer. When timing is proper, combinations may save some money and time.

Combination products can be recommended only when proper timing for the particular chemical has been determined. Combination products improperly used can be costly through turf damage and product wastage.

Lime

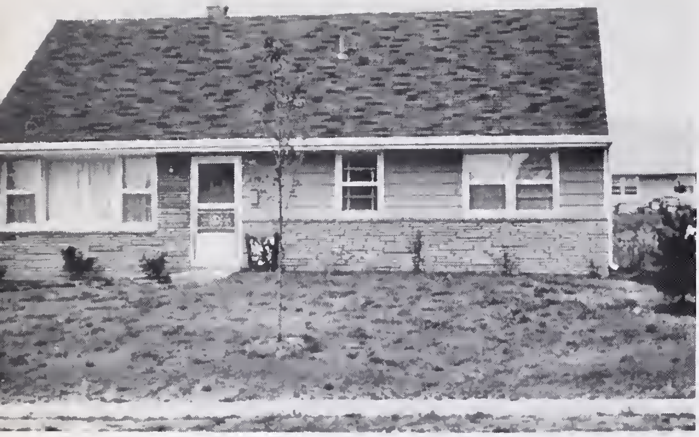
The addition of lime to lawn soils is also a frequent recommendation. This is generally true throughout the parts of the United States that are, or were, forested. Soils in these areas are generally acidic and may contain insufficient calcium and magnesium to meet the needs of healthy grass. The principal reason for applying lime to soils is to correct excessive acidity. In addition, lime improves the structure of the soil, increases its ability to absorb water, aids in the breakdown of excessive organic matter (thatch or mat), and provides available calcium and magnesium, which are needed in small amounts as plant food. Mildly acid and neutral soils are far more capable of supplying lawn grasses with the necessary requirements for healthy growth than are strongly acid soils.

TABLE 2
Ground Limestone Required to Correct Soil Acidity

	Limestone (lbs.) Required per 1000 sq. ft. to raise soil pH to 6.5		
Soil pH	Sandy Loam (Light)	Loam (Medium)	Silt Loam (Heavy)
4.0	140	180	250
4.5	115	150	200
5.0	80	115	160
5.5	60	70	90
6.0	25	35	50

Soil acidity is measured in terms of a unit called "pH." A soil which has a pH of 7.0 is neutral. Values lower than 7.0 indicate acidity; the lower the value, the greater the acidity. Values above 7.0 indicate alkalinity; the higher the value the greater the alkalinity. In general, soils in the northeastern United States have a pH range from 4.0 to 6.5 depending on the soil type and the past treatment. Usually, pH values below 5.5 are unfavorable for the thrifty growth of lawn grasses. A definite pH level is not critical but the desirable range is known to be 6.0 to 7.0.

The kind of lime most frequently recommended and available to lawn managers is "pulverized limestone." It is a finely ground rock containing oxides of calcium or calcium and magnesium. The latter type, often sold as "dolomitic" limestone is preferable because it contains two, rather than one, major elements essential for plant growth. As with fertilizers, labeling laws require that certain information be included on the container, so it is possible to determine whether one or both nutrients are included.



The "before" photograph shows a lawn in starved condition. The "after" photograph of the same lawn shows how it looked three weeks after being fertilized.

It is necessary to have the soil chemically analyzed to determine the pH level. This is a simple process performed by soil testing laboratories of the state Agricultural Colleges, by fertilizer companies or private concerns. When the level is determined it is a simple matter to determine the quantity of limestone required to create the desired change. See Table 2 to determine amounts of lime to apply.

Lime is inert and very slow acting. Ideally it should be mixed with the upper few inches of soil at the time of establishment and applied to the surface once every two to three years thereafter. It is all right to apply it annually but this is rarely necessary. Application is recommended in late fall when the turf is not in use. The dustiness should not prove objectionable at that time, and frost action during the winter will help work the material into the soil.

Do not expect a quick, visible response to the application of lime. Because the reaction is slow and the benefits are several and varied, there will be no sudden greening or thickening of the grass. Despite this, the lawn owner can rest assured that lime is a good investment on acid soils.

Proper lawn maintenance is not an easy task. Some technical information, considerable labor and expense, and much common sense are all required. Fortunately, the rewards of success are pleasant to behold and use. ◆

How to make the most effective use of water

LAWNS AND WATER

Fred V. Grau

WATER is essential for all of the life processes of grass and other living things. Life depends upon water in the proper quantities, in the right place, and at the right time. Many of us already are painfully aware of the consequences when unexpected limitations in water use are imposed upon us during drought. One of the first of such restrictions is the ban on watering lawns. Lawns that have been conditioned in advance for just such emergencies will be far superior to those which require a constant and large supply of water at all times. Briefly, then, it would seem to be good business to develop the kind of lawn which will be satisfactory with the minimum of supplemental irrigation and which will have the best chance of survival if and when water is denied or restricted.

Grasses are very efficient in extracting water from the soil for their life processes. Grass roots may draw water from a few inches to as much as 6 or 8 feet down. Grass roots will not grow in soils that are lacking in moisture. Lawns receive water from natural rainfall and, when this is not sufficient to sustain growth or appearances, from supplemental irrigation. The quantity of water supplied by rainfall, as well as the distribution of it, is highly variable. Among the factors which affect water use are the type of soil on which the lawn is growing, the kind of grass as well as depth of rooting and height of cut, the quality or degree of excellence demanded, the expected frequency of rain, and temperature, wind, and humidity. We have only begun to understand how each factor affects water use but, in spite of the seemingly complicated array of limitations, it is possible to make several simple statements which will help the lawn owner.

Our objectives are to maintain in the soil sufficient moisture for satisfactory growth and performance of the grass, periodically to replenish that which has been lost through drainage, plant use, and evaporation, and completely to recharge the soil to the full depth of the effective rooting of the grass. Irrigation to supplement rainfall should be applied only *as needed*. A rule is to space irrigation periods as far apart as possible. Another is to water in depth. Frequent light sprinkling or showers which wet only a shallow depth tend to induce shallow rooting. Shallow-rooted grass is poorly adapted to withstand traffic or periods of drought.

Soil Affects Watering

Soils are classed roughly as *sands*, *loams*, and *clays*. Sandy soils hold less water than clays and water drains through faster, so that watering needs to be done more often. Loam soils are intermediate between sands and clays. A 12-inch depth of loam soil may hold the equivalent of about 1½ inches of available water. Sands would hold about half that amount and clays about twice as much.

Water is more effective when the soil is open and porous so that it soaks in instead of running off. Most soils become crusted or compacted at the surface under the influence of traffic and watering. When this occurs there is less absorption and more runoff, resulting in waste of water, excessive costs, and actual damage to root systems and to the turf. Even though sandy soils tend to absorb water more easily than heavy soils, they too, become compact so that they shed water like a roof. The answer to this seems to be periodic aeration or cultivation with mechanical equipment to permit the easy infiltration of water.

A basic concept of watering, then, is to "apply water only as fast as the soil can

Trees complicate the watering problem because of the shade they cast and their own heavy need for water.

absorb it." It is difficult to overemphasize this because it is so very important. If sprinklers tend to apply water too rapidly it will be necessary to move them more often, bringing them back to a partially-watered area as soon as the first watering has penetrated, repeating this until the soil is wet to the full depth.

Every system should be checked occasionally for uniformity of application. This can be done quite simply in a practical way by setting out cans of equal size with straight sides every 5 feet in a row on both sides of the sprinkler. By running the sprinkler for a specified time (about 10 minutes) and then measuring the depth of water collected it is easy to determine how long the system must be run to deliver one inch of water. If the sprinkler is a good one, there will be the same depth of water in all the cans within its range.

Good drainage promotes the development of deep root systems that can utilize moisture effectively. Poor drainage makes it very difficult to grow good grass. The basic reason for this is that grass roots are living and need air (oxygen) just as you and I. Without the oxygen in the soil, grass roots are unable to absorb either water or nutrients. This is why grass turns yellow and dies when there is too much water in the soil over too long a period. Furthermore, soils are teeming with microorganisms which help to make fertilizer materials available to the grass and to develop humus which has a beneficial effect in holding moisture in the soil. These microorganisms also need air. Good drainage allows excess water to drain through the soil carrying harmful waste products with it and drawing fresh air into the soil.

Light sandy soils that drain very rapidly tend to develop deep extensive root systems because of the excellent aeration, but at the same time they lose dissolved nutrients more rapidly in the drainage water. This situation demands heavier, more frequent fertilizing which is beneficial to maximum root development. Heavy roots add organic matter to the soil which aids in holding water.

Water Requirements of Grasses

The usual method of classifying lawn grasses into cool-season (bent, blue grasses, fescues) and warm-season (Bermuda, zoysia, centipede, St. Augustine, Bahia, carpet) is not helpful when we consider water requirements. Based on water needs, we can make three groups of turf grasses.

1. Very drought tolerant: Bermuda grass, centipede grass, Bahia, zoysia, buffalo grass, grama grass, crested wheat grass, fescues.
2. Moisture loving (little or no drought tolerance): rough bluegrass, annual bluegrass, creeping bent, carpet grass, and St. Augustine grass.
3. Intermediate in drought tolerance: Kentucky bluegrass, some strains of bentgrass—especially colonial bent.

The deep-rooted grasses, like Bermuda, can effectively utilize the moisture in large volumes of soil and thus continue to grow for long periods between waterings. Some grasses escape drought by curling their leaves which reduces water loss through leaf openings; zoysias and fescues do this. Underground storage organs (roots and rhizomes) store food and moisture with which they renew growth following a period of drought which causes death of all top growth. Bermuda, buffalo, and bluegrass have such storage organs.

Some grasses slow down in growth during high temperatures (bluegrass, bent, fescue, buffalo) and refuse to be "pushed" even when water is supplied in abundance. Mis-applied water in these cases simply encourages unwanted growth of several weeds, crabgrass in particular. Bermuda and zoysia, on the contrary, respond to water and fertilizer during these periods. These are just a few of the more imporant considerations in choosing the grass for the lawn.

Well-fed Grass Resists Drought

Recent experimental work has proven that plants which are adequately supplied with nutrients actually require less water for growth and development. We have known for a long time that well-fed lawns suffer less from drought and they can go longer periods between waterings and still look better than lawns that are starved. There is little question but that well-fed lawns have fewer weed problems and that they can withstand wear and tear much better. It is safe to say that the majority of lawns suffer more from *starvation* than from lack of water. Yet we see on every hand, wherever we go, misguided attempts to make water substitute for fertilizer. The sensible approach to better lawns, then, first is to supply all the required nutrients in adequate quantities so that a constant supply always is available to the grass.

Regardless of the claims for various devices, one basic principle prevails—water should be applied uniformly and only as fast as the soil can absorb it. Intervals between waterings should be as long as possible and water should be applied only when the grass shows the need for it. Because of soil variations, some areas of the lawn may need watering more often than others. If, because of compaction or crusting or tight soil, it is not possible completely to "refill the soil reservoir" in one watering, it must be repeated at intervals until the soil is wet to the full depth of the root system. When runoff occurs it may be an indication that the soil needs loosening, aerating, or cultivating. (Repeated cultivating of a heavy soil will encourage root growth in the soil cavities and this will aid in water absorption.)

Perhaps the very worst practice in watering lawns is to hand sprinkle the grass every day or so (the curse of too little too often). This promotes a shallow root system and encourages weeds and diseases.

There has been a great deal of discussion about the best time of the day to water a lawn. Some say that watering when the sun is shining will "burn" the grass. Actually, the best time to water is when the grass needs it. The time of day makes little difference. There is less evaporation when water is applied in the evening but grass that is wet all night

runs the great risk of becoming diseased.

Watering a lawn is largely a matter of convenience, so someone is there to move the sprinkler, or to shut it off, when it is necessary. The human element of judgment is very important. A simple mechanical device known as a "soil probe" is important also so the depth of penetration of water can be determined.

A screwdriver pushed into the soil will penetrate easily if the soil has been thoroughly wetted. Dry soil will resist penetration. Also extremely important is the ability of the individual to recognize the appearance of grass that is in need of water. The best time to apply water is just before the grass starts to wilt. Each grass develops a characteristic appearance when this stage is reached and only close observation can determine this.

Bluegrasses and bentgrasses tend to develop a bluish cast when they begin to wilt. Zoysia grass takes on a blackish appearance. Wilting usually starts in one spot (the driest) and spreads. Few grasses are harmed by occasional wilting and they usually recover quickly when water is supplied. Severe wilting over too long a period, however, can cause grass to die. Bentgrasses are the most susceptible.

Supplemental watering of lawns can provide adequate soil moisture for satisfactory growth and pleasing performance. However, the water we apply can add to our problems by encouraging weeds and increasing the incidence of diseases. Watering costs time and money and causes us to mow more often. Crusting and soil compaction tend to become worse. The most serious drawback is the possibility that, during a drought period when the grass needs water the most, municipal decree may limit water for lawns because of short supplies for domestic uses. Such drawbacks to supplemental watering should strengthen our resolve, 1) to select the best lawn grass for a given situation, one that requires minimum irrigation, 2) to cultivate our soils to achieve maximum absorption of rainfall and irrigation water, and 3) to fertilize adequately and thus reduce the need for irrigation.

Watering an open lawn with no trees is an entirely different proposition than watering one which is interspersed with trees of assorted kinds and sizes. Trees complicate the problem by virtue of the shade they cast, the need for different grasses, and the heavy tree use of water. So to maintain the best possible lawn through all kinds of weather:

1. Make sure the soil is in condition to receive the water, whether it be rainfall or irrigation, and aerify as needed.
2. Make sure the grass is adequately, but not excessively, fertilized.
3. Water only when needed.
4. Soak thoroughly to effective root depth, but move sprinklers or shut them off if the soil cannot absorb as fast as the water is applied. Turn the water on again when the soil is able to absorb it, and repeat until it is soaked to desired depth.
5. Do not water again until it is really needed. Use a screwdriver or a soil probe frequently.

As an example, I should like to cite instances where I have seen well-fed Bermuda grass remain attractive and hold good color after 90 to 100 days between waterings. Starved turf went completely brown in less than half the time; both were in daily temperatures of 100° F. Well-fed 'Merion' bluegrass has resisted these high temperatures and remained in good condition for 35 to 40 days between waterings.

Most lawns that receive supplemental irrigation are watered with sprinklers. These may be of the pop-up type that are buried in the turf, sprinklers that attach to recessed valves, or moveable sprinklers that are attached to a hose.

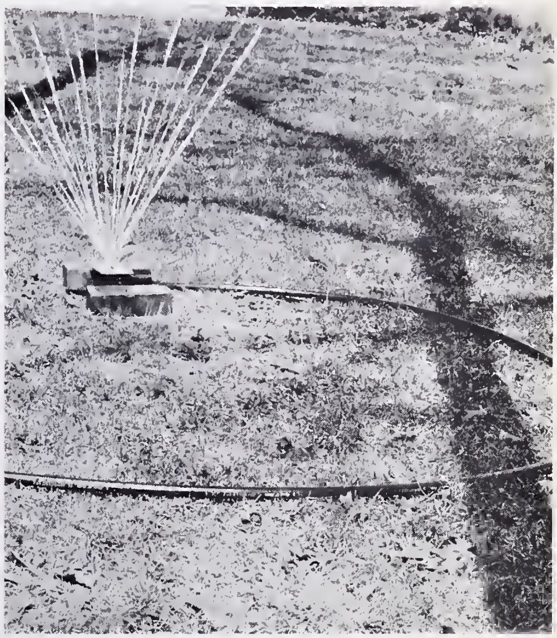
It is possible now to install automatic sprinkling systems that rely on moisture-sensing devices in the soil which, by activating a sensitive switch, are able to turn the system on and off as required. Unless de-activated, such a system could be embarrassing during a lawn party!

Permanent installations of underground pipe with "pop-up" sprinkling heads demand careful engineering to obtain even coverage under many conditions. ◆

Marjorie J. Dietz

STEPS IN INSTALLATION OF UNDERGROUND SPRINKLING SYSTEMS. Although such systems can be installed by the home owner, they require careful engineering to succeed under a variety of conditions. Wind and trees can prevent even water distribution. Inadequate water pressure can hinder efficiency of pop-up sprinklers.

Underwater systems utilize plastic pipes which are immune to freezing and so do not have to be laid deep in the turf.



Before permanently burying the plastic pipes, a "dry run" is recommended to test the adequacy of the sprinklers.

FIRST AID FOR FAILING LAWNS

When a lawn fails the first question that needs an answer is "Why did it happen?"

W. H. Daniel

A COMMON experience is to have certain large trees shade the lawn beneath—or rob it of nutrients and soil water. Excessive wear from foot traffic is another common reason for having to repair small areas. There are limits to what any turf will stand. These vary, depending upon the way in which it is treated.

Plant "adapted grasses" is a basic rule. Grasses not adapted to the climate and soil fail even with good care, so proper grass selection is essential.

A rule of thumb is, "Lawn grasses will withstand abuse in use, but not abuse in care." One muddy football game may spoil the green look of a field with a bluegrass turf, but the rhizomes should quickly put out new leaves. However, if the cutting was too low for the leaves to produce sufficient carbohydrates for rhizome development, then little regrowth can be expected even without muddy games. So a second basic rule is to cut the grass high enough to provide sufficient leaf area. For newer bluegrasses a 1-inch height can be ample. For bent even ½ inch can be ample.

Other steps necessary to attain maximum resistance to wear include adequate fertilization to insure continuous growth, proper watering, and keeping the soil sufficiently loose and open to provide good air and moisture supply. Even when all these things are done properly, sometimes excessive wear or accident will require special renovating operations to restore good turf quality.

Improvement by Spot Sodding

Sometimes on important areas—a home lawn, beside a front walk, or near a sidewalk, bare patches develop and improvement is needed. In many cases the best and simplest way of repairing these is by resodding. Quite often it is possible during the late fall or early spring periods to go to the edge of the flower garden, shrub beds, or other border areas and take small chunks of sod which can be set into the bare areas with a minimum of effort. Since this sod is already growing and does not need to germinate and establish itself, its chances of surviving in these difficult areas are much better than are those of a few seeds promiscuously spread with an idea that "seed will cure the ill." If the amount of sod removed from a back lawn, or a less important area along the edge of a bed is large, this out-of-the way area can be reseeded and very soon reestablished to conform to the rest of the lawn.

The use of small pieces of sod set into bare areas on banks where erosion is a problem is doubly advantageous. Using such small pieces in early spring, there is a minimum need for carefulness, yet erosion can be controlled and the lawn smoothed for maintenance during the summer. When available, sod pluggers often work more satisfactorily for such operations than shovels do. Rolls of sod can be readily purchased and used to repair larger areas. If used, be sure to set sod uniform and as low as older sod.

Spot Renovations by Seeding

Many home owners annually overseed the entire lawn area, as a step in overall renovation. This is seldom necessary and usually results in a maximum waste of seed with minimum improvement. It is much better to concentrate on the thin and bare spots.

Reseeding is most successful when it is done early in the spring or in the early autumn, so the seed can germinate and be ready to grow during cool moist weather. Accepted procedures include application

of fertilizer and lime if needed, spreading the desired lawn grass seed mixture, and shallow raking to remove dead grass and weeds without damaging the existing grass plants. Powered vertical rakes offer rapid uniform seedbed improvement. If done conscientiously these may contribute to improved stands with a minimum investment in time and cost.

Using Mulch

When it is necessary to seed bare areas, the use of some type of mulch is recommended. Of the several materials available—peat moss, straw, sacking, or pea gravel—each has its advantages and often it is a matter of supply or past experience which dictates whether one of these or no mulch at all will be used. For small areas fine pea gravel (¼ inch or less) serves to reduce surface erosion, yet keeps the seed below in place and moist. It soon disappears in soil and grass.

For larger areas straw mulches are excellent. Straw usually stays in place rather well if kept moist and if the edges are stabilized against driving winds. Peat moss is neat to use and readily available. Although it filters among existing grass easily, when used on totally bare ground it can dry out fast and then can be blown away. Or if used in thick layers, it may form an inhospitable blanket over the seed, preventing moisture from reaching the seeds.

The home owner may use various kinds of sacking if it is understood that the purpose of the sacks is to keep the seed underneath moist until it germinates. The sacks should then be removed so the seedlings get maximum sunlight. Too often they remain on indefinitely with the result that in areas where the best germination occurs, poor survival of seedlings results because of shading and excess moisture under the sack.

Lawn Repair Under Trees

A common problem of the home owner is bare lawn areas under shade trees. Can a satisfactory turf be produced under such conditions? Certainly, if one knows how and is willing to make the effort.

1. Under a good-sized tree, put on a

Marjorie J. Dietz

This gardener is improving a small section of lawn area by "spot sodding." Often it is quicker and more efficient to transplant sod into bare spots than it is to reseed.

Roche

A Mason jar with a perforated lid makes a handy utensil for "spot seeding" in lawn renovation. Even in small areas it is difficult to properly distribute grass seed by hand.

bale or more of peat, out to 5 feet beyond the spread of the tree. (When worked into the soil, peat moss retains extra moisture and nutrients, increases the soaking in of water, and softens the ground.)

2. Spread 25 pounds of a complete turf fertilizer (for example, 12-4-8 or 23-7-7) on top of the peat moss. If tests show the soil to be too acid, add ground limestone as recommended.

3. With your back toward the tree, spade and mix in the above materials as deeply as possible, using a well-sharpened shovel. This will destroy the tree's small surface feeder roots which rob the turf of water and nutrients. Large tree roots have lost their ability to absorb moisture and fertilizer, so let them alone. The tree will put out new feeder roots, and it already has many deeper ones. Meanwhile, the grass has a chance to get established with less tree root competition.

4. After spading, level the ground and spread 5 pounds more of fertilizer and 1 pound of grass seed over the whole area. (Some companies prepare shade grass mixtures which include new disease-resistant bluegrass and new, improved fine-textured ryegrasses.)

5. Rake lightly. Any peat moss that works to the surface will act as a mulch. If desired, a thin layer of pea gravel about $\frac{1}{4}$ inch deep will hold the seed in place and cut down evaporation.

6. Dampen the new seeding every other day in dry weather until the seedlings are $1\frac{1}{2}$ inches high.

Pointers for Repairing Lawns Under Trees

Seed in Fall It is easier to establish a dense turf under trees by seeding in the fall. As leaves drop from the trees more light gets to the grass. Keep fallen leaves from newly-seeded areas!

Use Shade-tolerant Grasses If dry, use 'Chewings' red fescue, particularly under coniferous trees.

Aerify the Soil In routine maintenance after new grass is established, it is good to aerify and, if dry, to water adequately. A hand aerifier is on the market that will, with about a half-hour's work, completely aerify the area under one tree. The common spading fork can be used as a substitute for the hand aerifier for punching and prying holes in soil and sod. ◆

Establishing lawns by sodding is a relatively recent development and has become a widespread practice

INSTANT LAWNS FROM SOD

James B. Beard

SODDING is a method of vegetatively establishing a mature, acceptable turf. The main advantage of sodding is that it is the fastest and cleanest way to obtain a quality turf grass surface for immediate use with the least problems from soil particles being carried or blown into the house. A second advantage is that the home owner does not have to become involved with the various steps in establishing a good lawn from seed. He can purchase a healthy, weed-free sod that he then maintains through standard mowing, fertilizing and watering practices.

When to Sod

Sodding can be done anytime during the growing season—provided there is adequate moisture for rooting from either normal rainfall or through an adequate watering system that is available on the site. The "growing season" can best be described in terms of the mowing period, which extends from the time the lawn is first mowed in spring until the last mowing in fall. But sodding should be avoided during mid-summer drought unless watering is available. The precipitation patterns and temperatures are usually most favorable during the spring and in the late summer-early fall period, particularly September. Where possible, it is desirable to sod sufficiently early in the fall so the roots can fully knit into the underlying soil. This generally requires three to four weeks. Late fall or early winter soddings made when temperatures are unfavorable for rooting may not survive the winter. The chance of losing a dormant sodding is very small if snow cover persists over winter, but serious damage may occur if the winter is dry and windy.

The procedures for preparing a site for sodding are the same as for seeding. They can be summarized as follows:

An example of an "instant" lawn that was installed from sod in one day.

The soil on which the sod is laid must be well prepared, fertilized and level.

1. Control persistent, problem weeds before cultivating the soil.
2. Remove rocks, wood and other debris; do not bury them on the site.
3. Cultivate the soil deeply and grade it roughly.
4. Install surface contour and subsurface drain tile, if needed, to remove excess water.
5. Modify the soil texture if necessary.
6. Incorporate lime into the soil if pH is below 5.5.
7. Apply fertilizer, based on a soil test, and mix it into the top 3-4 inches of the soil.
8. Prepare, level and firm soil.

Take enough time in soil preparation to make sure that the proper surface contours are established. It is very difficult and expensive to change them once a turf is established. The grade should be an inch or an inch-and-a-half below the sidewalks and driveways to allow for the sod thickness. On sites where a considerable quantity of soil has been filled into low areas, allow time for soil settling. The plant bed should be firm, but with a granular soil that is free of rocks and large clods of soil. Such a condition will ensure the most rapid rooting of sod into the underlying soil. This is very important because the longer the sod lies on the surface of the soil, the greater the likelihood that desiccation and death of the sod may occur during periods when the atmosphere has a high-drying capacity. Transplanting on rocky, compacted, improperly prepared soils usually results in poor rooting into the underlying soil.

Sod Selection

Many problems can be avoided if good sod is purchased. Specific characteristics desired in a high-quality sod are: a dense, uniform, green appearance; adequate sod strength so the sod can be handled and transplanted rapidly with little danger of tearing; freedom from serious weeds such as quack grass, sedge, creeping bentgrass and annual bluegrass; freedom from damaged areas indicating the presence of insect, disease or nematode pests; a minimum thatch layer; and a sod of sufficient maturity so ample carbohydrate reserves are available for quick rooting into the underlying soil.

It is preferable to spend a little more money for a high-quality sod than to purchase a low-quality, less-expensive product that can contain undesirable weeds or turf grass pests, which must later be dealt with at considerable cost and inconvenience. Sod prices for most cool-season turf grasses, such as Kentucky blue grass and red fescue, are usually quoted on a per square-yard or square-foot basis. There are 111 square

After the sod has been laid, it is rolled to ensure its contact with soil.

Michigan State University

A thorough watering is essential after the sod has been laid and rolled.

yards in 1,000 square feet and 4,840 square yards in an acre.

Select turf grass according to the conditions of the site. For example, under mature shade trees, the choice should probably be a turf containing a significant or major portion of fine-leafed fescue, either red or 'Chewings' fescue. The most common species used on unshaded lawn sites in the East is Kentucky bluegrass. Purchase a sod containing a blend of two or more Kentucky bluegrass cultivars (varieties) for unshaded, poorly drained sites.

Sod Harvesting

Successful sod transplanting involves rapid rooting or "knitting" of the sod into the underlying soil. The roots are initiated primarily from the horizontal underground stems of Kentucky bluegrass and red-fescue sods. Thus, the more stems that are severed during harvesting, the more rapid the rate of sod rooting. It is preferable to buy sod which has been harvested at a relatively thin depth, providing the sod has acceptable sod strength and adequate irrigation is available on the site during the initial rooting period. Kentucky bluegrass and red-fescue sods are normally harvested at a soil thickness of between 0.5 and .08 inch. Thinner-cut sod roots faster and is lighter in weight for ease of handling during transplanting. Thicker-cut sod is more tolerant of dryness but will root more slowly. If the sod is cut too thin it will be very prone to drought injury.

The period of shipment from the sod field to the lawn site should be as short as possible. Sod which remains in a stack for an extended length of time can heat up to lethal high temperatures. Sod heating is most likely to occur on warm days and during periods of extensive seed-head development. Even though the heat levels may not reach the point where there is visible damage to the above-ground shoots of the turf, there can be serious damage to the root system, impairing the rate of subsequent rooting into the underlying soil. Such damage can happen when temperature levels in the sod stacks reach 95° to 105° F. Above these temperatures death of the turf grass shoots is likely to occur. If there is an unexpected delay in transplanting, the sod should be stored in a cool, shaded location.

The maximum rate of sod rooting occurs when the underlying soil is moist at the time of transplanting. This means that final soil preparation should be accomplished just prior to sodding, in order to retain as much moisture in the soil surface as possible. Watering just prior to transplanting as a means of providing moisture is not satisfactory because the

soil surface will be too muddy.

The transplanting procedure involves carrying the sod bundles or pieces to the site, followed by unrolling or positioning the pieces in a staggered, checkerboard pattern. It is helpful to position the first sod pieces along a straight edge such as a walk or driveway. Do not stretch the sod while handling or unrolling. If excessive stretching occurs due to improper handling, shrinkage during drying is apt to result in objectionable 1- or 2-inch cracks between the sod. The edges of the sod pieces should be joined in good contact but not overlapping. Proper contact of the edges will minimize drying and prevent dying of the ends and corners of the sod pieces. It may be necessary to secure sod pieces placed on steep sloping areas by means of wooden pegs driven through the sod and into the soil. This will lessen slippage of the sod before rooting.

Immediately after the sod has been placed on the site, the areas should be tamped or rolled to ensure good contact between the sod and underlying soil. Rolling should be perpendicular to the direction in which the sod lengths were transplanted, if possible. Rolling and/or tamping is done to eliminate air pockets between the sod and underlying soil that can result in severe drying of the roots and rhizomes and subsequent lack of sod rooting.

Finally, the sod should be thoroughly watered as soon as possible after transplanting and rolling. If the area to be sodded is very extensive, it may be necessary to begin watering the completed portion while other areas are still being sodded. Visual wilting of the transplanted sod is a warning signal that watering should be started immediately. Sufficient water should be given at the time of the initial irrigation so the underlying soil is moist to a depth of 6 to 8 inches. The rate of application should be very slow so as to permit deepest penetration and to avoid runoff.

Note: It is better to incorporate fertilizer in the soil prior to transplanting the sod than to apply it over the surface immediately after.

Post-transplant Care of Sod

Watering and mowing are the primary cultural practices that the home owner must be concerned with immediately following transplanting. After the first deep watering, the sod should be watered regularly to ensure adequate moisture in the sod and underlying soil surface. These follow-up irrigations do not require a large quantity of water, but it is important that they be given daily, preferably at midday when evapotranspiration is greatest. Thin-cut sod will require more frequent waterings than thick-cut sod.

The cutting height and mowing frequency of newly-sodded areas should be the same as normally practiced on established turfs of the same species. The normal cutting height for Kentucky bluegrass and red fescue is in the range of 1.5 to 2 inches, with the higher cutting height preferred in shaded locations. The mowing frequency should be such that no more than one-third of the leaf area is removed at any one time. It is better to delay the first mowing in order to allow good rooting of the sod into the underlying soil. Also, this delay will lessen the chance of the sod ends being lifted and cut by a rotary mower or being caught in a reel-type one.

Fertilization of newly-transplanted, high-quality sod should not be required. There is usually at least a six-to-eight week period before a fertilizer application, usually nitrogen, is needed. The decision on when to fertilize should be dictated by a decline in the shoot growth rate of the transplanted sod and a visible yellowing. Similarly, no broadleaf weed control practices should be necessary during the first year or two, providing good sod has been purchased.

One final consideration is traffic control. This is of particular concern on sites that are normally subjected to much wear or on soils that become quite soft and prone to foot-printing or rutting when deep irrigation is practiced. It is usually necessary to place traffic control barriers around these sodded areas until good rooting has been achieved. ♦

Marjorie J. Dietz

Deeply rooted oak trees offer opportunity for a satisfactory turf.

The problem of maintaining

LAWNS IN SHADE AND ON STEEP SLOPES

Ralph E. Engel

TWO of the common problems confronting many home owners are shade and steep slopes. Unfortunately, grass failures are frequent on these areas, which are apt to become the most unsightly portions of otherwise attractive lawns. All lawns have certain minimum requirements for moisture, nutrients, light, and air circulation. Adequate amounts are often lacking where shade and slopes exist. Deficiency of sunlight, in particular, not only causes poor growth, but leaves the grass susceptible to various ills. Many of these situations can be improved with some additional care or attention to special needs.

Growing the Shaded Lawn

Shade is most serious under such trees as evergreens, Norway maple and beech. The evergreens cast shade all year; the Norway maple is well known for its heavy surface rooting as well as for its dense shade. Elms, oaks and sycamores usually produce less dense shade and offer a better chance for growing a satisfactory turf. But the difficulties vary even with trees of the same species, depending upon how closely they are planted and the distance of the branches above the ground. Shade, by itself, does not kill grass abruptly; it weakens the grass until it may fail suddenly from some other cause.

Buildings may add to the shade problem. While they do not deprive the grass of nutrients and water, they prevent air circulation and increase the difficulties where dampness is a problem.

One of the first things to do in dealing with a shady lawn area is to estimate how serious the problem is. If the shading is extreme, it may be necessary to eliminate some of the shade or to select some

Photograph by Arthur Norman Orans, Paschull Campbell, Landscape Architect

Some slopes can be made more gradual. Retaining walls can be built to create two or more levels. Low walls are less dangerous and become part of the landscape.

ground cover other than grass. English ivy (*Hedera helix*), pachysandra (*Pachysandra terminalis*), and periwinkle or "myrtle" (*Vinca minor*) are satisfactory for any but severe climates. Some of the more extreme shade problems can be overcome by removal of both lower branches as well as some of the higher growth of trees or removal of poor and surplus trees altogether.

Turf grasses differ greatly in their shade tolerance. Red fescues ('Chewings', 'Highlight', 'Jamestown', 'Pennlawn' and 'Ruby') and rough-stalked bluegrass are the commonly used shade-tolerant grasses of the humid northern regions. The red fescues prefer a well-drained soil, while rough-stalked bluegrass will tolerate wet, shaded locations. Velvet bentgrass is a good shade grass in cool, humid climates, but seed of this species is scarce. Among the cool-season grasses, Kentucky bluegrass and 'Colonial' bentgrass do not tolerate dense shade; among the warm-season grasses, Bermuda grass is very intolerant of shade.

Seedbed preparation for shady areas generally requires more initial effort and soil improvements than is necessary for the rest of the lawn. For step-by-step instructions, see page 23. An extra precaution that should be taken is to sow the seed in late summer or early fall. Wherever deciduous trees are present, planting at these seasons will give the maximum time for the grasses to become established before the leaves return. On occasion, seed can be spread in the winter. This may still give the grasses a sufficiently early start to become established before the trees leaf out in the spring.

Sod may be used to establish a turf in shade. However, be sure to prepare the soil correctly and to obtain turf of shade-tolerant grasses. If these points are overlooked, there will be no benefit from direct sodding.

Care of Shady Lawn Areas

Fertilization Occasionally, shaded lawns will hold good cover with little or no fertilization. When this condition exists, especially on red fescue, fertilizer might be omitted. More commonly, on most shaded lawns, it is necessary to apply fertilizer. An application of 4 to 6 lbs.

per 1000 square ft. of a 12-4-8 fertilizer or equivalent can be applied 1 to 3 times from September through early November and repeated once the following March when more growth is needed. Sometimes, smaller rates of application can be used for better appearance in the spring and summer if proper attention is given to watering.

Deep feeding of trees has been used as a means of encouraging deeper tree root development, leaving more nutrients and water at the surface for the grasses. This is done by driving holes into the soil to a depth of 2 or 3 feet and pouring fertilizer into these openings. If the trees have already developed an abundance of surface roots this procedure may be less beneficial. Also some kinds of trees may persist in their shallow-rooting habits in spite of such measures. When trees are outside the lawn area, pruning their roots where they enter the lawn will help.

Watering Use care in watering the shady lawn. Excessive watering and slow drying that is typical of shaded lawns can lead to serious disease problems. Water only in dry periods when the grass starts to suffer; don't delay until the grass is partially dead. Apply the water very slowly over a long enough period of time to provide deep penetration to recharge the dry soil. Frequent light watering may be necessary where the grass is shallow rooted.

Mowing Avoid close mowing and mow as high as possible on severely shaded lawns. An increased amount of grass leaf area increases food manufacture. A minimum cutting height of 1½ to 2½ inches is recommended. Do not allow large amounts of clippings to remain on the shaded lawn. This prevents the much-needed light from reaching the grass.

Considerable amounts of debris such as twigs and leaves may collect on the lawn under trees. These should be removed by gently raking. Use care to avoid injuring the grass plants which are weak and often poorly rooted.

The growing of lawns on slopes is difficult because seed, soil and fertilizers applied to the surface are often washed away. If fertilizer, lime, water and other materials fail to penetrate the soil in appreciable quantity, the turf suffers. On slopes with a southern exposure, high temperatures may destroy the turf. Other factors may add trouble for the grass, for example, steep slopes are often damaged by mower wheels which tend to slide.

Care of the Lawn on Slopes

Since fertilizer has a tendency to wash off the slopes, applications should be lighter and more frequent than on level lawns. This will aid in growing a turf cover of greater density. Possibly two or three extra applications could be made per year during the cooler growing periods of fall and early spring.

Slopes with a southern exposure are the first to require water in hot, dry weather. Do not delay until the grass is dead. Water very slowly to avoid run-off and to permit penetration into the soil.

If the cover is thin and the soil is very hard, some spiking of the slope will reduce the washing of fertilizer and other materials off the slopes. A number of machines are available in different styles and sizes which should help overcome this problem, or, if the slope areas are not large, it can be done by hand.

Use a high cut on slopes where such species as Kentucky bluegrass and red fescue are grown. This will reduce run-off and insulate the soil against water loss and heat. These grasses can tolerate a meadow-like condition of only two or three mowings a year. Some find the high, infrequent mowing method quite satisfactory for such areas.

The problem of slopes can always be dealt with directly. Some slopes can be made more gradual. Retaining walls can be used to create two levels. When possible, avoid high walls; lower ones are less dangerous and they can be a beautiful part of the landscape. Bear in mind, though, that some very steep slopes may always prove troublesome for grass. Where this is the case a ground cover such as ivy or periwinkle may prove more satisfactory. ♦

Correct diagnosis is the first step

DISEASES OF THE HOME LAWN

Herbert Cole, Jr.

NOT all problems associated with lawn failures are due to disease-causing fungal organisms or nematodes. All too often, we rapidly jump to conclusions and assume that: "My grass is not growing properly. It must be a disease." We immediately march off to the garden center, buy one of the appropriate fungicides as recommended by the garden store dealer, return home, spray the lawn, and wait for the miracle results. Unfortunately the miracle seldom comes due to inaccurate initial diagnosis. Thus the homeowner's problem is one of diagnosis.

There are several physical problems related to the growing of grass that are often confused with fungal diseases. Water—the right amount, or too much or too little—and plant nutrients—in proper balance, or lacking or present in excess—are examples. Excesses can create just as many problems as sbortages.

Soil structure can create problems. Compacted clay areas, sandy areas that dry too rapidly, areas that do not allow water penetration, or areas that allow water to accumulate on the surface all can create difficulties. Dense shade and varying shade levels influence grass growth. Excessive amounts of shade that occur as trees expand their crown areas can rapidly alter the types of grass species, and create problems for grass growth underneatb. Temperature will effect growth, especially on exposed, sunny locations on steep banks where the temperatures of the soil surface and the grass growing in these areas can greatly exceed the temperatures in other areas that are exposed to partial shading conditions. Snow and ice accumulation, flooding during the winter, winter salt from deicing compounds that are swept and shoveled onto tbe lawn all can influence grass growth and in the spring can give the illusion of being a disease problem rather than physical factor and may be very easily mis-diagnosed. In urban areas and even suburban areas, air pollution can affect grass growth. In other situations, crown- and root-feeding insects, such as grubs, chinch bugs, sod webworms can be easily confused with fungal disease organisms rather than with insect problems.

Among tbe specific turf grass diseases tbat follow are some that are spectacular in appearance, some that can cause lasting damage and others that are of fleeting importance.

TYPHULA SNOW MOLD (*Typhula itoana*)

Symptoms This disease is usually first conspicuous after the spring thaw as the snow leaves the lawn. It is usually most prevalent in those areas where the greatest snow accumulation has occurred, such as along driveways, along the house where a major drift may have accumulated and lasted well into the spring, or over the brink of a hill—again where snow drifts tend to accumulate. The most notable symptoms that will be seen after the snow disappears are white crusted areas where the grass blades are dead and bleached and matted together. These areas can range in size from several inches to several feet in diameter. The chief diagnostic feature of Typhula Snow Mold is the presence of hard dark brown to light brown pinhead-sized fungus bodies called sclerotia embedded in the leaves and crowns of tbe matted grass leaves.

Cultural Control Usually successful in home lawn situations. Mow the grass into the fall to avoid a collection of high, unclipped grass that tends to fall over and mat. Use snow fences where drifts are likely to be present. Use care in trying to distribute snow from sidewalks and driveways so it does not produce

long-lasting accumulations. Rake and break the crusted, matted leaves and provide a situation that encourages the production of new foliage and new growth in the affected turf areas.

Chemical Control Use when cultural control has failed. Applications must be made prior to the first permanent snow cover in the fall. In many areas this may be around Thanksgiving. (See page 41 for controls.) Normally a single application at this stage will provide satisfactory control. At the time of symptom appearance in the spring, there is little in the way of chemical treatment that is useful.

FUSARIUM SNOW MOLD (*Fusarium nivale*)

Symptoms This disease may be a true snow mold in that it appears under snow cover, but it also can be a cold, wet weather disease that can occur anytime from late October to early April or even into late April when periods of cold wet weather occur with temperatures in the 40-50° F. range. The disease is also called pink snow mold from the accumulation of pink fungus spores that pile up on the foliage of infected areas underneath snow cover and result in a pink cast to the affected area. Individual grass blades may also seem red or pink due to these masses of spores. Another diagnostic feature is the *absence of the pinhead brown sclerotia* which are common with the Typhula snow mold. Usually only leaves are attacked, but under very favorable conditions for disease development, the fungus can kill the crowns and roots as well; and in this sense, can be a much more severe problem than Typhula snow mold.

Cultural Control Practices mentioned for Typhula are also important for control of Fusarium snow mold. In general with both diseases, the bentgrasses are most susceptible, followed by annual bluegrass and lastly, the bluegrass-fescue mixtures which are normally used on home lawns. Thus, in many situations, if the selection of grass species initially in the home lawn are bluegrass-fescue combinations, snow molds will be minimized. However, if during the life history of the lawn, a species shift occurs towards the bentgrasses and annual bluegrasses, then snow molds can become a progressively worse problem.

Chemical Control Chemical control may be needed on bentgrass and annual bluegrass lawns. Treatment should be considered only where a past history of unmanageable Fusarium snow mold outbreaks has occurred. In cold wet areas, an early fall (October) treatment may be needed.

HELMINTHOSPORIUM LEAF, CROWN, AND ROOT DISEASE (*Helminthosporium* sp.)

This group of diseases is incited by a complex of fungus organisms, all of which are members of the genus *Helminthosporium.*

Symptoms Every grass species that exists in the world probably has had a Helminthosporium leaf spot and crown rot disease associated with it. These organisms, under pasture and native grassland conditions, result in leaf spots that are of little consequence. However, as one reduces the grass cutting height and increases the fertility level, especially nitrogen availability, these leaf spot diseases move rapidly from being a curiosity to a severe problem that may result in almost complete loss of the turf. Severe infection may open the grass stand for weed invasion. With bluegrasses, Helminthosporium fungi usually first invade the leaves and result in definite leaf spot symptoms. These can begin as dark purplish-red, ovate-to-round areas on the blades which enlarge until the entire width of the leaf blade is affected. All leaf tissue above the spot usually withers and dies. In the bentgrasses, more extensive water soaking and general blighting results from initial infection, and after a few days distinct spots are not visible.

The leaf spotting is of lesser consequence in damage to the turf grass stand when compared to the crown and root phases of infection. Crown and root decay are responsible for the term "melting out" which is often used as the name for the disease. The turf area literally melts

away. Where ten or even more individual grass leaves may be attached to a single tiller or grass plant, successive infections of the Helminthosporium fungi reduce these numbers of leaves until only a single leaf or no leaves remain on the plant. At this stage, the turf is very susceptible to mechanical damage due to walking or varied recreational use. Normally most severe during the spring, outbreaks can occur anytime during the growing season depending on the fungal species and grass species or variety present.

Cultural Control The practice commonly used by most home owners, which involves an early spring application of a nitrogen-containing fertilizer, will make this disease much more severe than no fertilizer treatment. There are research reports from various experiment stations in the eastern United States that show that high nitrogen fertilizers applied immediately prior to the period of lush growth in early spring make the grass plants far more susceptible to this disease than grass growing under lower nitrogen fertility or in fact a shortage of nitrogen. Hence, that nice, lush, dark green early growth that we feel is typical of a good lawn is really the kind of growth that results in the disaster that we see in May due to Helminthosporium infection; and the most important control recommendation is *no or very limited early spring nitrogen fertilizer.* Apply it in September of the previous fall during the period when—in many bluegrass varieties—rhizome production is occurring, or apply a light application of fertilizer in early- to mid-June to provide nitrogen in the summer period. At the early spring stage of the year in most lawns, grass growth is occurring fast enough and color is satisfactory. Adding too much nitrogen results in excessive growth, the accumulation of clippings, and organic matter that we don't need, and creates more problems than benefits.

Chemical Control Fungicides are effective for control of Helminthosporium diseases, but correct application and timing is critical. Fungicides applied at the melting-out stage, when the damage is readily apparent, usually result in no control. Recovery at this time becomes a matter of trying to encourage regrowth of weakened grass or, if loss is really severe, over-seeding to provide new plants. An effective preventative fungicide program requires first application in very early April when the grass begins to green and then repeat applications during late April and early May at two-week intervals.

SCLEROTINIA DOLLAR SPOT
(*Sclerotinia homoeocarpa*)

Symptoms This is a disease that on golf course greens cut at 3/16 or 1/4 inch height results in dead turf areas about the size of a silver dollar, hence its name *Dollar Spot.* However, when we move from a golf green to a home lawn which is cut at an inch or 2 inches or even 3-inch height, it is no longer dollar spot. The dead areas now can reach the size of 3 to 6 inches in diameter. These coalesce, resulting in the killing of large areas of turf. Affected individual leaves show yellow-green blotches which rapidly bleach to straw-colored tan with a reddish-brown margin. Dollar spot can occur anytime during the period from early to late summer. Traditionally we think of it as a disease that reaches its peak activity when air temperatures are into the 80° F. range, but there does not really seem to be an upper limit on temperatures. Dollar spot is most severe on those home lawns that receive regular, closely spaced summer watering. However, it can occur under high humidity conditions in the absence of irrigation and associated with prolonged "muggy summer weather." Dollar spot is very often more severe during periods of nitrogen stress when the grass is growing very slowly.

Cultural Control The nitrogen fertilizer application delayed until June to minimize the Helminthosporium diseases will also provide growth that will help minimize the dollar spot problems during mid-summer.

Chemical Control Where irrigated turf has experienced persistent previous

dollar spot problems, there are now available systemic fungicides which are very effective against most forms of the organism and which can be applied in very low dosages, either as granules or as liquid spray programs. Perhaps this is one place where the use of a fungicide in very low dosages may provide disease control in a home lawn situation and yet be a feasible investment both from the view of time and equipment.

FUSARIUM BLIGHT (*Fusarium roseum* and *F. tricinctum*)

Fusarium blight must be considered as the major disease problem on fine quality bluegrass home lawns in the eastern U.S.

Symptoms Symptoms are first apparent to home owners in mid-summer as areas of dead or dying turf that can be from a few inches to a foot or more in diameter. Very often a serpentine pattern of dead grass or perhaps frog-eye spots appear; i.e., dead areas with tufts of green grass in the center that give a frog-eye appearance or perhaps a ring appearance. Sometimes these rings may overlap; other times they stand out as rather prominent dead individual rings. Fusarium blight symptoms seldom occur in newly seeded turf areas. Normally in a new bluegrass lawn, Fusarium blight will not appear until at least the fourth or fifth year in the life of the stand; then each year thereafter, its symptoms get progressively more severe and the damage can move from a curiosity to a real disaster for the home owner.

We do not fully understand many of the factors related to the development of the disease. The causal organisms are members of a very widespread fungal genus that causes diseases on all kinds of plant species, including perennials and annuals. Environmental conditions that favor Fusarium blight are periods of warm wet weather followed by drought periods without rain. If we were to define a typical favorable period where the disease is most likely to occur, it would be several days or week-long periods of high humidity and intermittent rains, with temperatures in the high seventies and eighties, followed by clearing weather and lack of rain for several weeks. Sometime during the second week without rain, the grass in certain areas of the lawn will begin to turn a blue-green and hang limp in the heat of the day. This may occur for several days and then the grass literally collapses and bleaches to a straw color in just a few days or perhaps a twenty-four hour period. The roots and crown areas as well as the foliage are killed; the only way that affected areas can fill in and regrow is by rhizome development during the September and October period from adjacent healthy grass or by reseeding. The symptoms are striking and can represent disaster when twenty or thirty per cent of a fine quality lawn is completely destroyed by this disease. Some research scientists have suggested there may also be an association between root-feeding nematodes which damage the roots and provide entry for the fungus into the roots and crown area. The combination of the root-feeding nematodes and the fungus together result in the quick demise of the plant. In general, the disease is much more severe under high fertility conditions. That old patch of bluegrass lawn that is treated pretty much as a pasture has very few problems with Fusarium blight. It is the home owner who has really cared about his lawn and applied the ultimate in high fertilization who has the troubles.

Cultural Control Some of the new systemic fungicides, which are listed in the fungicide section, will provide control if applied on a preventive basis. However, the cost of applications are high and for many home owners, we feel the cost cannot be justified. Perhaps the best answer is manipulation of cultural practices, i.e,. varietal mixes, removal of clippings, removal of thatch, and aerification; and if the disease does appear, move in with reseeding, with blends of blue grasses, and hope that this will keep the disease at a minimum.

Fusarium blight is most severe on the sunny, exposed areas of lawns which tend to dry out rapidly, such as southern banks. On the other hand, it is seldom

seen underneath shade or on northern slopes that are protected from drying conditions. In general, Fusarium blight is also much less of a problem during cool wet summers or when adequate moisture can be maintained throughout the growing season. Such conditions avoid the extreme variations in available moisture that appear in many seasons when we have periods of hot rainy weather followed by drought periods and then return to more hot rainy weather. These types of fluctuating moisture levels, especially warm moist weather followed by a drought period, seem to be most favorable for disease development.

SMUT DISEASES—*Striped Smut* and *Flag Smut* (*Ustilago striiformis* and *Urocystis agropyri*)

Symptoms Striped and flag smut are most pronounced during the early-to-late spring and again during a secondary period of early and late fall. During mid-summer, symptoms are almost nonexistent or at the very most an occasional diseased tiller may be found. Infected turf grass plants are usually stunted make slow growth, and may be off-color in either a yellow or grayish cast, compared with healthy, vigorous growing grass. As the disease progresses, long yellow-green streaks develop on the leaves of affected plants. These streaks can become gray or black in color and soon the epidermal layers covering the streaks rupture, exposing underlying black spore masses. After this takes place, the leaves soon split and curl from the tips downward—giving the affected turf the appearance of being shredded or curled. Severely diseased turf is more prone to weed invasion, likely to be thin, and more susceptible to physical abuse such as caused by children playing or recreational activities. However, turf that during the early spring gives the appearance of being very severely diseased can recover rapidly with the onset of warm weather and by mid-summer the symptoms which appeared to be bordering on a disaster situation, can be much lessened.

Culture Control Where a history of striped smut infection of a lawn has occurred throughout the years, fertilization in the fall—to promote vigorous development of new tillers and thickening of the turf—will help to minimize the reduction in density and thinning that normally occurs in the spring from this disease. Varieties of Kentucky bluegrass differ greatly in their resistance to striped and flag smuts. Among the more common varieties of bluegrass, 'Merion', 'Cougar', 'Newport', 'Prato', and 'Windsor' have been reported as quite susceptible. However, due to the changing picture of strains and races of the smut organism, this may not hold for all areas. Other varieties, which have been reported as resistant, may be susceptible in certain areas or locations where races of the fungus are able to attack that variety. For this reason, hard-and-fast varietal recommendations cannot be given and varietal control can be best based on planting blends of bluegrasses. This should provide a broad base of genetic resistance.

Chemical Control Certain systemic fungicides, which are listed in the fungicide section, have provided quite good control of striped smut. They are drenched into the turf during the dormant season in early spring prior to greening, or in the October period of the preceding fall. Chemical control, however, cannot be made a general recommendation because of the varying levels of damage that have occurred from infection. When taking into consideration the cost of the treatment versus potential damage, it is a very difficult decision as to whether the fungicide investment should be made.

DAMPING OFF, also known as seed rot or seedling blight (*Pythium, Rhizoctonia, Fusarium*)

Symptoms When turf grass is planted in the early fall or in the very early spring, damping off and seed decay are seldom problems. However, if seeding is attempted during the May, June, July, and August periods, in many instances, especially if hot weather occurs, the seed may decay prior to germination; or the

new seedlings after germination may blight and fall over. Even young seedlings after a month or even two months' growth can start to die and collapse in patches. Affected seedlings are often water-soaked and slimy and the dead tissues mat together in a paper maché-like crust over the surface of the soil.

Cultural Control Control is based on providing ideal conditions for the growth of a turf grass plant and germination of the seed and reducing those conditions which favor the fungus. In most instances, this may be accomplished by planting in the spring or fall period; or if planting in the summer, by providing a well-prepared seedbed, being sure that the seeding rate is sufficiently low that extremely dense stands are not produced, and by preventing free water from occurring on the soil surface.

Chemical Control Chemical control is based on a program of both fungicide seed treatment prior to seeding, fungicide drenching or spraying of the soil surface after seeding, and on occasion fungicide spraying of the young seedlings at various intervals after emergence and germination of the seed. The extent to which these various control practices must be integrated into a complete system depends on the location of seeding, the type of grass being seeded, and the seeding rate involved.

RED THREAD (*Corticium fuciforme*)

Symptoms From a distance, Red Thread appears as irregularly-shaped patches of blighted grass several inches in size and may create the appearance of large areas with a reddish cast.

The disease is restricted to the leaves and leaf sheaths. Early infection appears as small spots which rapidly enlarge, covering most of the leaf. The affected tissue dries out and the whole leaf fades to a tan color. With prolonged moist weather, the leaves can be completely covered with the pink gelatinous growth of the causal fungus.

Diagnosis of red thread is most certain in final stages of disease development. At this time, fine thread-like fungus structures, 1/16 to 1/4 inch in length and bright, coral-pink in color, are produced at the tips of the leaves.

Cultural Control Red thread is less of a problem at adequate fertility levels. Where the disease is severe the maintenance of adequate nitrogen levels will reduce the problem. However, at higher nitrogen levels Helminthosporium diseases can become damaging. In general, red thread is not as destructive as Helminthosporium leaf spot and crown rot diseases, and thus the use of nitrogen fertilizer as a control measure is questionable.

RHIZOCTONIA BROWN PATCH (*Rhizoctonia solani*)

Symptoms Rhizoctonia brown patch is a major disease of bentgrass home lawns and occasionally is a problem on bluegrass-fescue home lawns in mid-to-late summer during periods of extended high temperatures and high atmospheric humidities. On close cut turf, such as golf greens and bowling greens, Rhizoctonia brown patch appears as brown circular areas. Ranging from a few inches up to 2 feet in diameter, the coloration of these patches is at first a brownish-purple, which rapidly fades to brown as the leaves dry out.

Where high mowing is practiced the diseased areas range up to several feet in diameter. These patches of light brown grass are more or less circular in outline and occasionally may be appressed to the soil surface, thus, creating a sunken or "pocket" effect.

The chief distinguishing feature of Rhizoctonia brown patch appears during active infection in periods of warm, humid weather when dark, purplish "smoke rings," ½ to 2 inches wide can border the diseased areas. More pronounced in the hours of early morning, these rings usually fade by the middle of the day.

Cultural Control In planning a control program, soil-fertility levels must be considered. For example, on a lawn of known Rhizoctonia brown patch history, the application of an additional amount

of readily available nitrogen fertilizer may create the need for fungicide applications.

Removal of water and exuded nutrients collected on the grass leaves each morning as the result of heavy fog, guttation, or dew has proven effective over the years as an aid in reducing Rhizoctonia brown patch. This may be done by sweeping the turf with a bamboo pole or dragging a water hose across the area. Water turf in the morning so that grass dries before nightfall.

PYTHIUM BLIGHT (*Pythium sp.*)

Symptoms Pythium blight, also known as grease spot and cottony blight, can be a most destructive turf grass disease, especially on bentgrass and ryegrass. Severe outbreaks may result in complete destruction of the turf grass within *several* days from the onset of weather conditions favorable for disease development. After a severe outbreak, it is often necessary to completely renovate the turf. Pythium blight first appears as small, irregularly shaped spots, ranging from ½ to 4 inches in diameter. At first water-soaked in appearance, the leaves soon shrivel and the color of these patches fades to a light brown. Groups of affected patches frequently join together. At times, the shape of the affected areas resembles elongate streaks. This disease development pattern is apparently the result of the fungus being washed over the surface of the soil. The presence and pattern of these streaks are determined, mostly, by the surface water drainage flow of the area. In early morning, or if high humidity exists throughout the day, diseased leaves can be covered with the white, cobwebby, mold-like growth form of the pathogen.

Cultural Control In Pythium-blight problem areas, a cultural program that maintains satisfactory plant growth through low-level balanced fertilizer applications, provides the highest level of resistance on the part of the turf grass. Pythium blight is most severe on unbalanced high-nitrogen lush-growing grass.

In the northeast U.S., bluegrass-fescue home lawns usually do not require fungicide treatment. Bentgrasses and certain pure stand ryegrass plantings may need fungicide protection, especially where a history of previous infection has been noted.

SLIME MOLDS (*Myxomycete spp.*)

Symptoms Grass blades as well as the surface of the soil can be covered with a creamy white, translucent, slimy growth. In a few days, this slimy overgrowth changes to masses of pinhead size, varying colored, (white, blue, purple) reproductive bodies of the fungi. The affected turf areas may assume the various colors of the individual bodies due to the thousands of these bodies covering the leaves. Varying in size from a few inches to many feet, the shape of the areas range from circles to streaks.

Cultural Control Slime molds can be removed by sprinkling the leaves with water. This method should only be used after the onset of dry weather and the threat of further development is past. If the leaves are washed during a prolonged rainy period, the organisms may be further spread to previously unaffected areas. Removal of spore masses by raking, brushing, or poling will aid in returning the grass to normal appearance.

FAIRY RING (*Mushroom fungi*)

Symptoms Fairy rings appear as more or less continuous circles of turf grass that are darker green and faster growing than the adjacent plants. These bands may range from 4 to 12 inches wide, with the diameter of the circles varying from 3 to 200 feet. Frequently, several distinct rings will occur in the same area. Where they converge on each other, fungus activity ceases at the points of contact and as the result, the circular shape of the original rings can be replaced by a scalloped effect. In some instances, the center of the ring may contain weakened or dead grass or the ring may be double with an outer and inner zone of stimulated grass surrounding a band of poorly growing turf. Damage to turf is more severe during

Brown patch is most troublesome on home lawns in summer during periods of extended high temperatures and high humidity. The patches of infection are most evident in early morning. Water lawns early in the day so the grass dries by night.

George Taloumis

drought periods.

In other instances during high rainfall periods, yellow rings of grass appear and then fade away as rainfall diminishes, only to return again during periods of high rainfall and rapid grass growth.

Fruiting bodies of the causal fungi, usually referred to as "mushrooms" or "toadstools," often appear in the rings in late summer during periods of high-soil moisture. Over ten fungal species have been associated with fairy rings.

The fungi obtain their food from soil organic matter. Growth begins when the organism, in the form of bits of fungal threads or sporophores, or less often as spore, is introduced into soil of a turf area. As the fungus grows through the soil, the first visible evidence of a new fairy ring is a cluster of the fungus fruiting bodies or a tuft of stimulated dark green grass. Then, the fungal threads progress outward from the point of origin and formation of the circular ring-like pattern becomes apparent.

Rate of outward movement varies from 3 inches to 2 feet per year. Although some fairy rings are over 200 feet in diameter, most are from 3 to 12 feet across. In the British Isles, the largest rings have been estimated to be over 400 years old.

Cultural Control Admire them for their unique contribution to the lawn's appearance! Maintain sufficient growth rate and frequent mowing to minimize the differing growth rates between the ring and the rest of the grass. Where rings stunt or kill the grass, it may be necessary to remove the sod, remove the top 6 inches of soil, and reseed or re-sod the area. Punching the ring with holes to improve water penetration can be helpful.

Chemical Control Attempts to control the rings with fungicide drenches have met with only limited success. Chemicals used have been highly toxic.

POWDERY MILDEW (*Erysiphe graminis*)

Symptoms The fungus is usually first seen as isolated wefts of fine, gray-white, cobwebby growth on the upper surface of the leaves. This growth rapidly becomes more dense, and can cover the entire leaf, giving it a gray-white appearance. In cases of severe outbreaks, portions of entire grass stands can be dull white, rather than green.

The organism survives the winter months in dead grass leaves from the previous season, and in the dormant state in infected grass plants. Spread by air movement, the spores germinate and the infection process begins within two hours

from the time they land on the leaf. Conditions favorable for the development of powdery mildew include: reduced air circulation; high atmospheric humidity, but no water on the surfaces of the leaves; low light intensity; and cool air temperatures. The disease is usually more severe on turf grass growing in shaded areas than in full natural light.

Cultural Control Where powdery mildew is of frequent recurrence, changes to improve air drainage and reduce turf shading will aid in disease reduction.

Resistant Varieties Various turfgrass varieties differ in their susceptibility to powdery mildew. The broad-leafed bluegrasses, for example, are more susceptible to powdery mildew than narrow-leafed types. However, selection of a narrow-leafed type, solely because of its higher powdery mildew resistance, cannot be justified because of other disease resistance and cultural characteristics entering the picture.

RUSTS (*Puccinia* and *Uromyces spp.*)

Symptoms Early infection appears as a light yellow flecking of the leaves. As these areas enlarge, they can become somewhat elongate and when numerous, show definite arrangement in rows parallel with the veins of the leaves. Soon, with

FUNGICIDES WITH MINIMAL ENVIRONMENTAL HAZARD FOR USE FOR TURF GRASS DISEASE CONTROL ON HOME LAWNS

Listed below are some of the more appropriate chemicals to be used in conjunction with other good management practices. Apply the spray formulations in 1 to 5 gallons of water per 100 sq. ft. of grass area. Granules and drenches should be applied with suitable equipment as specified on the container label.

Chemical dosages for turf grass use often vary with the disease to be controlled and whether a curative or preventative program is involved. Thus, specific dosages are not listed in these recommendations. Carefully follow the dosages suggested on the container label. An overdose can injure grass and pose a hazard to people and animals touching the grass. Be sure to follow all label precautions and usage directions. Do not permit spray to drift onto other areas. Dispose of empty containers.

Prior to using a turf grass fungicide, be certain of the disease diagnosis. Then, plan and carry-out a complete disease-control program, including the related management factors. Haphazard use of fungicides on lawns or other turf areas seldom is effective.

DISEASES	FUNGICIDE (when listed by common name, some examples of trade names are given in parentheses)
Seed treatment for prevention of seed decay, damping off, and seedling blight in new seedings	Thiram (Thiram 75%, Arasan 42 S, Arasan 70 S) OR Captan (Captan 75%, Orthocide 75)
Helminthosporium leaf spot and crown rot	Dyrene 50% WP OR Maneb with zinc (Tersan LSR) OR Zinc ion maneb (Fore) OR Daconil 2787, 75% WP OR Actidione—Thiram
Sclerotinia dollar spot, copper spot, red thread	Benomyl (Tersan 1991) OR Thiabendazole (Tobaz, Mertect 140 F) OR Daconil 2787, 75% WP OR Dyrene 50% WP OR Actidione—Thiram

the rupture of the cuticle and epidermis, the spots develop into reddish-brown pustules. Severely infected plants have a rusty appearance similar to rusty iron; hence, the name, rust, for this disease. When infected leaves are rubbed between the fingers or when one walks through severely infected turf, a red powder can be collected on the fingers and shoes. This powder is composed of millions of tiny spores which are the reproductive bodies of the fungus.

Cultural Control Adequate nitrogen fertility in late summer to maintain growth will minimize rust accumulation. In most years, rust will not become a damaging problem, although rusted areas may be an off-color yellowish-orange.

Resistant Varieties Broadleafed varieties of Kentucky bluegrass are usually more susceptible to *Puccinia graminis* than common or narrow-leafed Kentucky bluegrasses. They, however, cannot be given preference solely because of high resistance to rust. Certain new ryegrasses will also become rusted during late summer.

NEMATODES

Symptoms Nematode injury symptoms are similar to those associated with poor fertility. The plants exhibit these

DISEASES	FUNGICIDE
Rhizoctonia brown patch	Benomyl (Tersan 1991) OR Thiabendazole (Tobaz, Mertect 140 F) OR Thiram (Thiram 75%) OR Maneb with zinc (Tersan LSR) OR Zinc ion maneb (Fore) OR Daconil 2787, 75% WP OR Dyrene 50% WP OR Actidione—Thiram
Pythium blight (includes seedling damping off and seedling blight)	Koban 35% WP OR Dexon 35% WP OR Chloroneb (Tersan SP) OR Maneb with zinc (Tersan LSR) OR Zinc ion maneb (Fore)
Snow Molds	
Fusarium pink patch	Benomyl (Tersan 1991) OR Thiabendazole (Tobaz, Mertect 140 F) OR Daconil 2787, 75% WP OR Dyrene
Typhula gray patch	Chloroneb (Tersan SP) OR Daconil 2787, 75% WP OR Dyrene 50% WP
Rust	Actidione—Thiram OR Actidione—Ferrated OR Maneb with zinc (Tersan LSR) OR Zinc ion maneb (Fore)
Powdery Mildew	Actidione—Thiram OR Actidione—Ferrated OR Benomyl (Tersan 1991)
Striped smut	Benomyl (Tersan 1991)

One way to avoid troubles with the home lawn is to water only when necessary. Then provide a thorough soaking rather than just a sprinkle. Before building a lawn, make certain that drainage is adequate and that water cannot accumulate.

symptoms—not because the nutrients are lacking in the soil—but because the roots have been destroyed by nematode feeding and cannot absorb the nutrients needed for proper growth and development. If poor growth, off-color, and thinning-out occur on turf and do not respond to fertilization, there is a possibility that nematodes are involved.

Plant parasitic nematodes are small roundworms, invisible to the unaided eye, which live in the soil and in the roots of many turf grass varieties. They feed on roots by piercing them with a spear-like mouthpart, similar to a hypodermic needle. The nematode moves through the soil, comes in contact with a root, pierces the root with the spear and injures the cells involved. This results in the destruction of many of the feeder roots and limits the ability of the grass to obtain minerals and water from the soil. Nematodes, feeding on the roots in this manner, produce small puncture wounds which are utilized by some fungi to gain access to the interior of the root and, thus, cause root decay diseases. In most cases, the fungi, which enter the root in this fashion, are problems only when nematodes are present in the soil, thus, contributing to the importance of nematode control. Nematodes are believed to contribute to the severity of Fusarium blight.

The majority of nematodes are free-living in soil, do not possess a spear-like mouth, and cannot injure plant roots. These nematodes feed on dead, organic matter, fungi, and insects in the soil and are beneficial.

Root zones of grass plants, that are just beginning to decline, are more likely to contain parasitic nematodes than soil from dead turf or turf areas that are in such poor condition that the roots can no longer support a nematode population. Mid-to-late summer is when populations reach their peak and will be most readily detectable. Accurate diagnosis of a nematode problem requires professional identification and soil analysis. Soil and root samples should be kept moist and cool after collection and until identification is completed. Samples collected from mid-October to May often show low populations because the nematodes are in the egg stage and are not detected by normal sampling techniques.

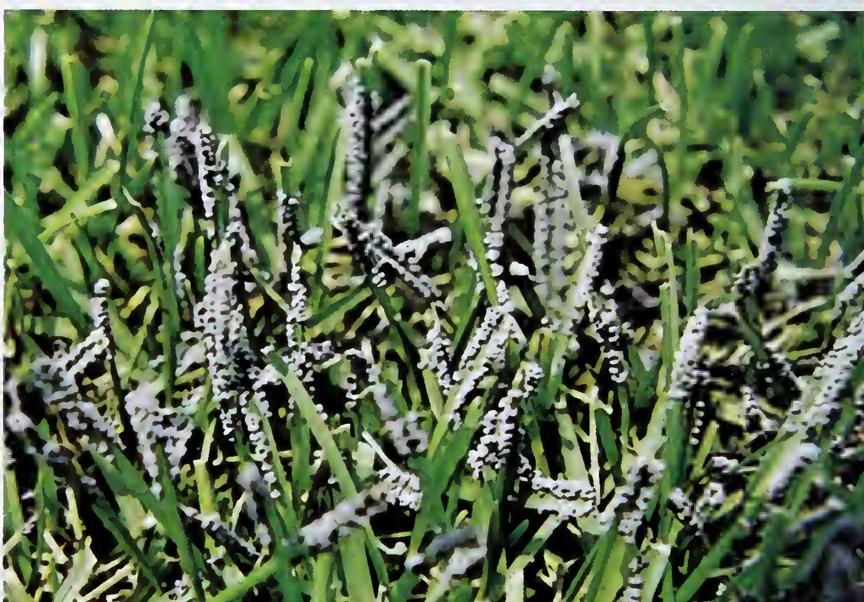
Cultural Control Vigorous turf grass with proper management will be more likely to suffer minimum damage from nematode injury. However, at present in the Northeast, knowledge of the factors influencing nematode population is so limited that clear recommendations cannot be made.

Chemical Control Nematicidal chemicals are available both as fumigants and drenches. Many of these are highly toxic to people. After professional diagnosis indicates that a severe problem is present, chemical treatment should be undertaken only as a last resort and then only by professional pesticide applicators. ♦


PORTRAITS OF LAWN DISEASES *Above left:* Typhula snow mold appears as snow recedes and is characterized by irregular brown-gray turf areas. *Above right:* Fusarium snow mold has reddish-pink margins on affected areas. Sometimes an affected area can show an overall reddish-pink cast.


Above left: Stripe smut is characterized by elongated black lesions and curling and twisting of blades. *Above right:* Helminthosporium leaf spot and crown rot in the blight phase, with grass blades showing spotting and blighting.

Above: The beginning of Pythium blight on new rye-grass seedlings. In early morning, white cobweb-like fungal growth is visible in areas of infection.



Above: Slime mold in shady section of lawn. Blue-gray spore masses on leaf blades become dry and powdery, coating everything that they touch.

Above: Fusarium blight has invaded the turf of a recreational park. In the most severely affected areas, 50 to 60 per cent of the turf grass is completely dead.

Above: A closer view of Fusarium blight. Note frog-eye symptoms, with tufts of green grass in center of affected area. Dead areas can extend to several feet.

Above: Close-up of lesions on individual grass blades caused by Sclerotinia dollar-spot. Note the straw color of the lesions and their red-brown margins.

Above: Sclerotinia dollar-spot as it appears on a 'Merion' blue-grass lawn. Infection centers are straw-colored and range in size from 1-4 inches in diameter.

INJURIOUS INSECTS OF LAWN GRASSES

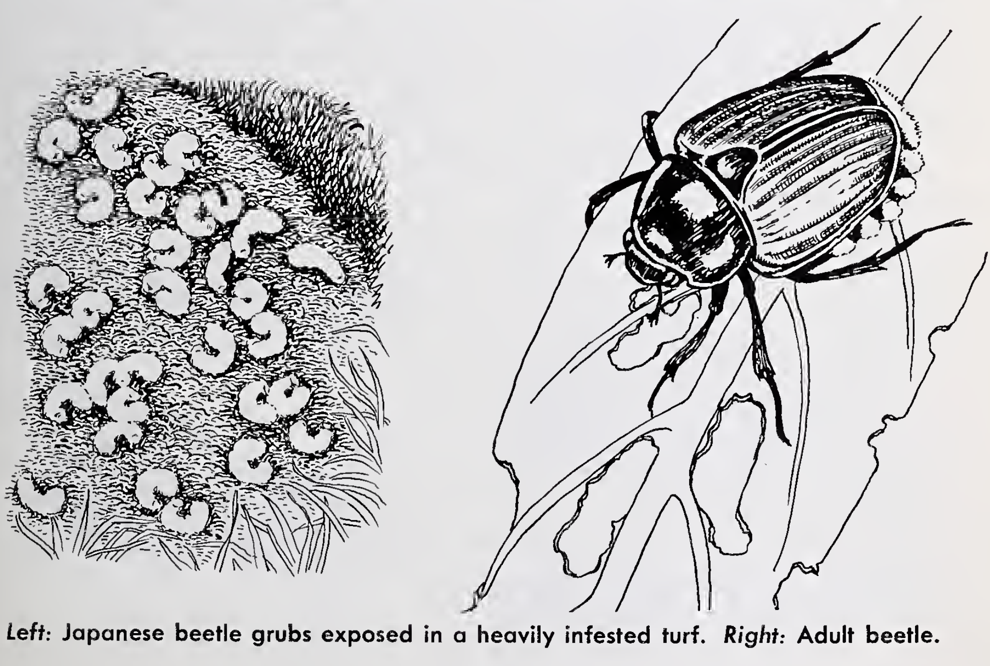
Herbert T. Streu

A NUMBER of insect pests attack and can cause damage to both cool-season and warm-season grasses. Serious damage generally occurs less frequently in northern than in southern-type grasses. In Florida, for example, insects are major lawn pests requiring almost constant attention, whereas in the Northeast, insect damage is probably less common than cultural and disease problems.

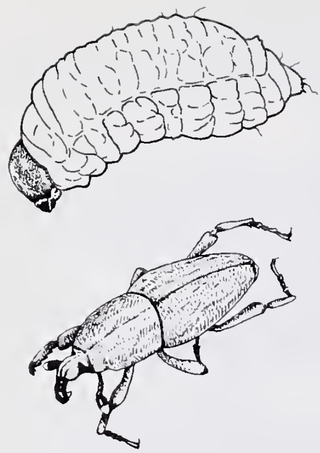
Since many lawn problems are somewhat similar in appearance, the homeowner must know how to diagnose an insect infestation. He must know how, where and what to look for before treatment can be made. Successful treatment depends upon early and accurate identification as well as selection of an appropriate insecticide and effective application. It is of utmost importance to know where the pest lives in order to get the insecticide to the insect. Following is a brief description of some of the major insect pests of turf grasses, based upon where the insect feeds and the kind of damage it can cause. Make sure the problem is caused by an insect before treating, because too much insecticide can be worse than none at all.

Some Insects Which Feed Below Ground

White grubs Grubs are the immature stages of a number of common beetles, including May and June beetles, Japanese beetles, as well as Oriental and Asiatic garden beetles, and others. Adult beetles lay their eggs in the grass usually in mid-summer. The grubs which hatch out are whitish and rather slow-moving. They have six legs, a yellowish-brown head with large jaws, and a typically dark-colored area at the tip of the abdomen. They feed on the grass roots, causing the



Left: Japanese beetle grubs exposed in a heavily infested turf. *Right:* Adult beetle.



Billbug larva *(top)* and adult

most serious damage when populations exceed 8 to 10 grubs per square foot.

Heavily infested turf grass at first turns brown and dies in small patches or areas, which later become more widespread. Since most of the grass roots are removed by the feeding of the grubs, infested turf can be easily pulled up or rolled back, thereby exposing the insects, which range from about 1 to 1½ inches long when fully grown, and which are typically found in a crescent-shaped position. Although the various species of grubs differ somewhat in size and life history, treatment is the same for all.

Billbugs The larvae of billbugs are grub-like in appearance but are smaller, have no legs, and are the immature stages of a snout weevil. Zoysia grasses are commonly attacked by both larvae and adults which feed on the underground parts. In New York the bluegrass billbug is an occasional pest on cool-season grasses.

Treatment Chlordane is the best pesticide for grub-proofing a lawn or for treatment of an established infestation. One treatment will last for at least 3 to 5 years under average conditions, and up to 10 or more years in heavy soils. It can be applied with a lawn fertilizer spreader as a 5 per-cent granular formulation at the rate of 5 lbs. per 1,000 sq. ft., or drenched into the lawn using a 45 per-cent liquid concentrate at the rate of 8 fluid ounces per 1,000 sq. ft. In either case, it is important to apply sufficient water to carry the insecticide into the soil and the grass-root zone. Under average conditions, use at least 25 gallons of water per 1,000 sq. ft.

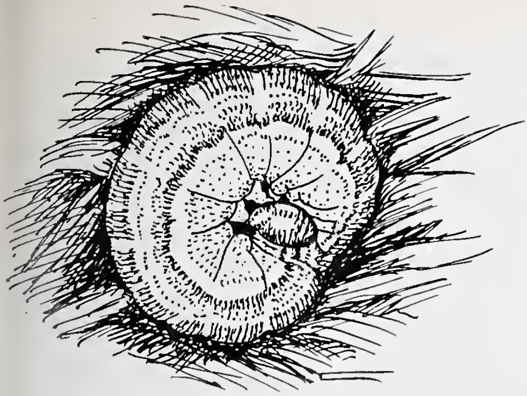
Chlordane should not be applied more than once every several years. Damage in lawns will result from continued or indiscriminant use.

Milky disease is a bacterial disease of grubs which can be used as a biological form of grub control. Spore dust can be applied to permanent turf grass when grub populations range from one to ten per square foot. The disease may take several years to become established but, once after that, affords permanent control. The rate of disease establishment depends upon soil temperature and grub population density. Therefore do not apply spore dust and pesticides which reduce grub populations at the same time.

Insects Feeding Above Ground

Sod webworms are the larvae of several species of lawn moths or "millers." The adults are small tan moths which hide in the grass and shrubbery during the day and fly over the grass laying eggs in the evening. Lawn moths will fly for only short distances when disturbed during the day, but are commonly attracted to lights at night. When at rest, the wings are folded around the body, and the long

Sod webworm—moth and larva



Larva of armyworm

palps at the head give the moth the appearance of having a long "snout."

The larvae, or "worms," live in the thatch at the soil surface, constructing silken tunnels within which they hide. Sod webworms feed on the grass blades, cutting them off close to the plant crown. Even recently established lawns have a degree of thatch, and webworms tend to prefer them to old lawns with deep and extensive thatch.

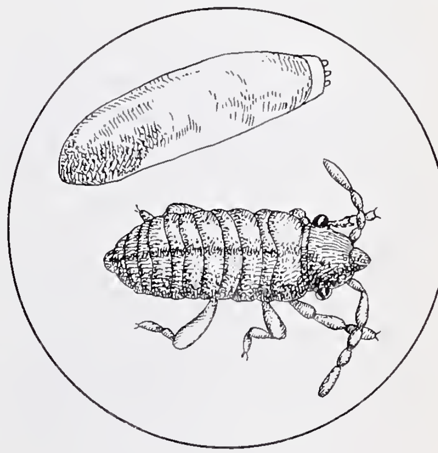
Damage appears as brown spots or dead areas in the lawn beginning in early summer. Heavy infestations may result in large, irregular areas being killed by midsummer. The larvae can be found by carefully picking through a suspected area with a knife, or similar instrument, looking for the silken tunnels and the green, pellet-shaped excrement. Mature worms are about three-quarters of an inch long, light brown in color with darker spots arranged along the body. Birds frequently feed on these insects, and bird feeding activity is a good indicator of an insect infestation.

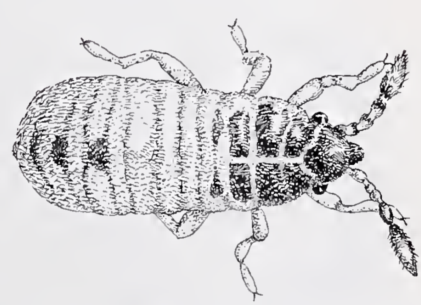
Adult short-winged form of hairy chinch bug

Cutworms and *armyworms* are the larvae of larger, more robust moths and occasionally cause damage similar to that of sod webworms.

Treatment Sod webworms, cutworms and armyworms can be controlled with drenches of carbaryl or diazinon applied at the rate of 8 and 4 ounces respectively of the 50% wettable powder per 1,000 sq. ft. It is best to apply these insecticides in the late afternoon or evening, using about 3 gallons of insecticide-water mixture per 1,000 sq. ft. Heavier watering, or a rain immediately following treatment, can wash the insecticide into the ground and will result in poor control.

Chinch bugs are serious pests of both northern and southern grasses. These tiny insects can become quite numerous during hot dry weather, reaching several





Immature stages of the hairy chinch bug. *Top:* Egg stage and first nymph stage. *Bottom:* Second nymph stage.

CHINCH BUG CONTROL

Insecticide	Formulation	Amount per 1,000 sq. ft.
Carbaryl	5% Granule	4 lb.
	50% Wettable Powder	8 oz.
Diazinon	5% Granule	4 lb.
	25% Liquid Concentrate	6-12 fl. oz.
Dursban	0.46% Granule	5 lb.

General

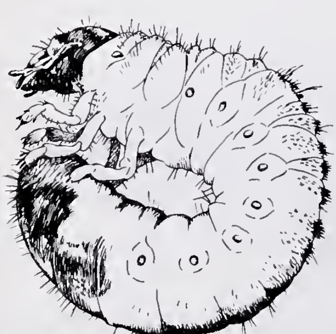
All pesticides are hazardous and should be handled with extreme care. Read and follow label directions concerning mixing, application and storage. Remember: Use pesticide chemicals with care. Careless and frequent usage can be worse than none at all! Regulations regarding pesticides differ from state to state.

hundred per square foot in the Northeast, while in Florida and other Gulf States, the southern species may reach a thousand or more.

Adult chinch bugs are about 1/6 inch long, are blackish, and have either short or long white wings with two blackish spots. When the long wings are folded over the posterior portion of the body, they give the appearance of a white "X"-shaped marking. Young bugs are bright red and when first hatched are about the size of a pinhead.

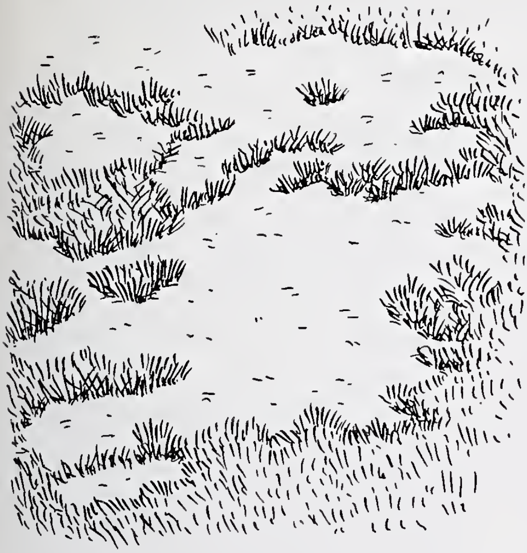
In the Northeast, the second generation is the largest and causes the most damage during August and early September. Chinch bugs thrive in established lawns with deep thatch, which provides protection for the insect colonies. They prefer hot dry areas and tend to congregate. As a result, dead or brown patches appear first on hot sunny slopes or in other well-drained locations. Under certain conditions an entire lawn can turn brown and die.

Identification of a chinch bug infestation can be made by partially sinking one end of a large can, open at both ends, into the turf at the edge of a brown area. Fill the can with water and watch for about 5 minutes for chinch bugs to float to the surface. Treatment can be made with any of the materials listed above, but it should be remembered that sufficient water must be applied to carry the insectide into the thatch. The best time to treat is in the spring before populations become large. ♦



Grub of the Japanese beetle.
(See also drawings on page 43.)

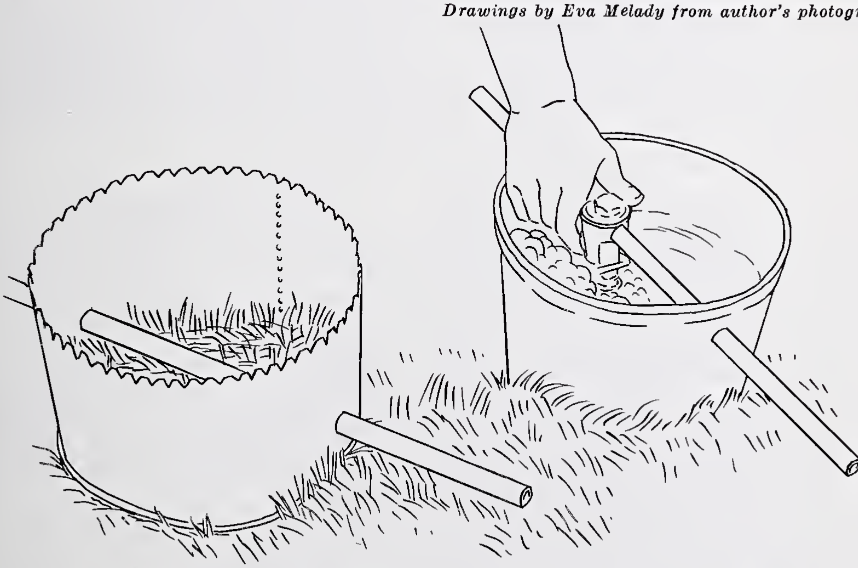
How to Identify Chinch Bug Infestations



Typical damage to lawn caused by infestation of sod webworm and chinch bug.

Adult long-winged hairy chinch bug. Note its size relative to the pencil point.

Drawings by Eva Melady from author's photographs



A demonstration of flotation method of chinch bug identification. Cylinder being filled with water (right); note serrated edge and pipe handle to facilitate soil penetration on inverted cylinder (left). (See text on page 46 for details. For immature stages of chinch bug, see drawings on page 45.)

All you need to know about

THATCH AND ITS CONTROL

Henry W. Indyk

The many attractive lawns so evident in most suburbs today are proof of the success of intensified lawn-care efforts which are based on modern practices. Yet, such well directed efforts at the same time contribute to an unfavorable condition for growth of lawn grasses known as thatch. In a sense, thatch is a natural condition that reflects the progress achieved in growing better lawns. Thatch has been long recognized by professional turf managers as a problem associated with the highly pampered grass carpet on golf courses. Now it is becoming a popular term among home owners.

What Is Thatch?

Thatch may be described as an accumulation of a dense layer of undecomposed organic debris between the visible green top growth of the lawn grasses and the soil surface. The somewhat spongy layer, ranging in color from a light to a very dark brown, can be easily separated and distinguished from the soil surface on which it forms. A close examination of a sample of thatch reveals a dense intermingled mass of leaves, stems and fibrous roots of the lawn grasses. The stems also include the below-ground runners known as rhizomes and above-ground runners known as stolons which are characteristic of certain lawn grasses.

A common misconception is that thatch is the clippings which remain on the lawn after mowing and accumulate at the base of the lawn grasses. In actuality, a close look at a sample of thatch will show that any clippings which have accumulated form a thin layer on the upper surface of the thatch layer and constitute only a small portion of the entire layer. Admittedly, clippings can contribute to the thatch problem. However, it is unlikely that they are one of the major factors involved for the following reasons: clippings are composed of succulent leaf tissue that is readily decomposed; thatch forms and persists in situations where all clippings have been removed; an examination of the physical composition of a sample of thatch reveals that it contains a relatively small amount of leaf tissue as compared to other parts of the lawn grasses.

The thickness of the thatch layer can vary considerably from lawn to lawn. It may range from practically nothing in certain lawns to more than 2 inches in others. The thickness of the layer can be easily determined by examining a small sample (2 to 4 inches square) of sod removed from the lawn. The sample can be obtained by cutting into the lawn with a sharp knife or garden spade to a depth of 3 to 4 inches and carefully removing the sample. Examination of its side profile will indicate a rather sharp dividing line between the somewhat spongy brown-colored thatch layer and the soil. Separation of the thatch layer from the soil usually can be made easily at the junction between them.

What Causes Thatch?

Although the exact reasons for thatch formation are not fully understood, a variety of factors alone or in combination are known to be involved.

Usually, thatch will form sooner and to a greater extent in the more dense and vigorous-growing lawns. Surprisingly, the very same factors that encourage the growth of lawn grasses also can contribute to the development of thatch. The rate and amount of thatch build-up is influenced by conditions that affect the decay of organic matter. Consequently, the presence of any condition that reduces decay naturally will favor the rapid development of thatch.

Some of the more important factors

that cause thatch are as follows:

Kind (species) of lawn grasses The differing growth habits of lawn grasses can account for differences in thatch formation. Lawn grasses with surface creeping stems (stolons), such as the creeping bentgrasses in the cool-season region and Bermuda grass, zoysia, St. Augustine grass and centipede grass in the South, tend to form thatch more readily than the lawn grasses, such as the Kentucky bluegrasses or red fescues, which do not possess this growth characteristic.

Variety of lawn grass Within each kind of lawn grass, more than one variety is available. Many of the lawn-grass varieties have been specifically selected for greater density and/or more vigorous growth, resulting in a greater tendency toward thatch formation. Among the Kentucky bluegrass varieties, 'Merion' is a typical example and 'Tifgreen' is one for Bermuda grass.

Composition of the lawn-grass tissues The tissues of certain lawn grasses are more fibrous than other lawn grasses. The "woody" nature of such tissues makes them more resistant to decay and therefore they tend to accumulate and form the layer of thatch. The surface runners (stolons) of such creeping grasses as bentgrass, zoysia, Bermuda grass, St. Augustine grass and centipede grass tend to be more resistant to decay than other plant parts because of their comparatively high fibrous composition. The red fescues and zoysias are not noted for their vigorous rampant growth but tend to contribute significantly to thatch build-up because of their very fibrous tissues which resist decay.

Lawn-care practices Any practice utilized to promote vigorous dense growth, particularly fertilizing and watering, increases the amount of organic material that can contribute to thatch accumulation. In addition, the possibility exists, although not definitely proven, that the use of pesticides to protect the lawn against damage or destruction from pests may also affect the microorganisms that decompose organic material.

Decomposition of organic matter The dead tissues of the lawn grasses undergo decomposition, thereby reducing the build-up of thatch. In the decaying process air, water and nitrogen are utilized by the microorga-

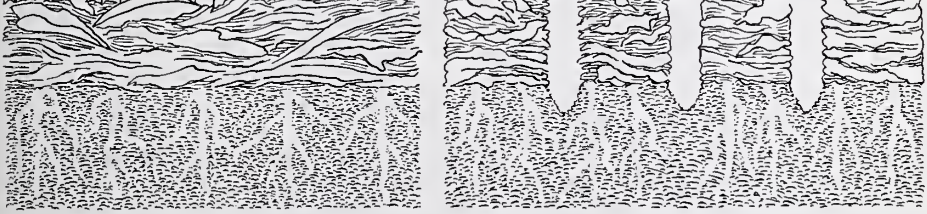


Diagram illustrating the effect achieved with a dethatching machine equipped with blades capable of penetrating the thatch layer. At left is appearance of a thatch layer before dethatching. On right is effect of proper dethatching.

nisms. A shortage of any one or a combination of these factors as well as the acid conditions resulting from decomposition are unfavorable for microbial activity.

Physical conditions of the soil Excessively moist soil conditions, particularly near the soil surface, due to excessive watering or even light frequent watering of compacted soils tend to produce shallow and surface rooting of the lawn grasses. The concentration of the root system at or near the surface can add to the thatch problem.

Top-dressing with organic materials The spreading of peat moss, humus, sawdust, manures or other bulky organic materials on the lawn adds to the organic layer on the surface and increases thatch problems.

Effects of Thatch

Limited amounts of thatch may provide some benefits to a lawn. Thatch can keep the soil cool under high temperature conditions and provide some protection against low temperatures. It can serve as a mulching material reducing the loss of soil moisture from evaporation and preventing the germination of weed seeds such as crab grass. The sponginess of the thatch layer provides a certain degree of softness and a cushion for play. When thatch is decomposed, plant nutrients are released and recycled for growth of lawn grasses. In addition, other products of decomposition can aid in the improvement of the physical condition of the soil.

The major interest in thatch is not for its limited beneficial value but for the adverse effects of excessive accumulations. These accumulations produce an unfavorable situation that hinders the healthy, vigorous growth of the lawn grasses in any one or more of the following ways:

Reduces the response to lime and fertilizer applications The movement of these materials from the surface into the soil where they are absorbed by the roots is restricted by the dense thatch layer. Consequently, larger applications are necessary to meet the needs of the lawn grases. However, in some serious thatch situations, even increased liming and fertilizing will not provide an adequate response in color and growth.

Impedes the movement of water Thatch can act as a sheet of plastic in preventing water received from natural rainfall or applied by a sprinkler from reaching and penetrating into the soil. As a consequence, lawn grasses can show symptoms of suffering from a lack of adequate soil moisture even though sufficient water has been received or applied. When thatch is dry, it is particularly effective in restricting the movement of water because of its high degree of resistance to wetting. On the other hand, when it is wet, the thatch layer may act as a sponge and hold excessive amounts of moisture above the soil surface during wet periods.

Restricts movement of air into the soil This reduces the supply of available oxygen to the roots.

Provides a favorable environment for lawn disease organisms as well as troublesome lawn insects. Furthermore, the thatch can provide protection for these pests against fungicides and insecticides. As a consequence, pest control becomes more difficult.

Generates heat and other decomposition products Heat can be sufficiently high to injure or even kill lawn grasses when thatch decomposes rapidly. Rapid decomposition can occur during periods of high temperatures, abundant moisture and very active microbial populations.

The detrimental or over-all effect of thatch on the lawn grasses is reflected in various ways. Top growth will be lacking in green coloring and vitality. The roots will be shallow and weakly anchored in the soil. Response to lawn care practices generally will be sluggish. Susceptibility of the lawn to drought, wear, weeds,

and to attacks of insects and/or diseases is greatly increased.

How To Control Thatch

Certain steps can be taken in a lawn-care program to prevent or reduce the rate of thatch formation before the ill-effects of excessive amounts are noted. Removal of clippings is perhaps one of the most commonly used practices with the misconception that they are the major cause of thatch. Clippings add organic material, thereby contributing to the thatch problem but, as mentioned previously, they are not one of the more important factors. Collecting, sweeping or raking the clippings can help prevent thatch formation to a limited degree but their importance tends to be stressed too strongly. Thatch will tend to form in lawns in spite of these clipping-removal practices. Therefore, practices other than clipping removal need to be considered in a preventative thatch-control program. One or more of the following practices may be helpful:

Lime Small amounts (20 to 25 pounds per 1000 square feet) applied annually will help reduce the acidity of the thatch as well as of the soil and stimulate bacterial action for more rapid decomposition of the thatch.

Fertilize Apply adequate amounts for maintaining green color and growth of lawn grasses but avoid fertilizing in excess of these needs. Excessive amounts stimulate growth and the production of organic matter, adding to the thatch problem.

Maintain adequate soil moisture Encourages decomposition due to more favorable conditions for bacterial activity. It also reduces the tendency of the thatch to resist wetting.

Avoid unnecessary and excessive use of pesticides.

Avoid spreading bulky organic materials such as peat moss, humus or sawdust as a top-dressing. Such materials add to the organic layer.

Top-dress with a high-quality topsoil mixture. Soil intermingled with the thatch encourages decomposition. This practice is commonly used on golf course greens but is somewhat prohibitive in cost on home lawn areas.

Remove fallen tree leaves in the autumn by raking or sweeping. Do not mulch or shred leaves and then return to lawn. Use this material on shrub and flower beds.

Aerify with spikers or preferably with a core aerifier They provide more favorable conditions for bacterial activity as well as growth of lawn grasses.

Dethatch mechanically using special hand rakes or powered equipment.

Whenever the thatch layer builds up to a thickness of more than a half inch, the need for curative control with special mechanical devices becomes increasingly important. The primary objective is to provide a means of overcoming the detrimental effects of thatch. An important and necessary feature of the curative control procedure is not only displacement of thatch but also complete penetration through the entire thatch layer to the soil with whatever mechanical device is used. This not only improves conditions for the growth of the lawn grasses by overcoming the restrictive characteristics of the thatch layer, but also improves conditions for its decomposition. Procedures which only remove thatch material from the surface of the layer would be of little value. Seldom is it necessary to dethatch a lawn more than once a year. However, where there is a serious thatch problem, more than one treatment per year will be advantageous.

The best time of year is when the lawn grasses are growing actively and are not under heat or drought stress. Lawns containing the cool-season grasses should be dethatched in the early spring or fall, but fall is preferable. When dethatching in the spring, there is a possibility of increasing the chances of crab-grass infestation due to the thinning of the lawn. For this reason, it might be well to consider applying a preemergence crab-grass killer as a part (the last step) of the procedure in the spring. The late

spring-early summer period would be most appropriate for lawns in the South.

The actual procedure for dethatching a lawn is neither difficult nor complicated. The suggested steps are as follows:

1. Close mowing—if the top growth is more than 1 inch tall, set mower cutting height at ¾ to 1 inch; mow and remove clippings.
2. Make a note of all areas that are bare, sparse and weak. They need special consideration.
3. Apply 25 pounds of ground limestone and 10 pounds of a 10-6-4 (50% organic fertilizer) per 1000 square feet or any other high nitrogen fertilizer at an equivalent rate.
4. Dethatch with thatching machine which can be rented. Set adjustment on machine so that the blades penetrate through the thatch layer and at least ½ inch into the soil.
5. Seed all bare and weak areas as noted above.
6. Drag with steel door mat, twice if necessary. Before dragging, allow sufficient time for the loose thatch material and soil on the surface to thoroughly dry.
7. Lightly rake thatch material remaining on surface after dragging and remove from lawn. Thatch material can be composted for future use in garden or shrub beds.
8. Thoroughly water.

Equipment for Thatch Control

Most interest and effort in controlling thatch involves mechanical devices specifically developed for this purpose. A wide range and variety of devices are available and promoted under such names as aerifiers, hand-rakes, power rakes, thinners, thatchers, vertical mowers and others. For sake of convenience, they shall be referred to collectively as dethatchers.

Devices that are available as dethatchers include the following:

1. Hand rake specially designed with a curved blade with a sharp edge.
2. Aerifiers basically consist of two types—spikers and core-aerifiers. Spikers have solid tines that make angular depressions which help to some extent in admitting air, moisture, lime and nutrients. The core-aerifying devices have hollow tines which punch holes by removing a core of soil (¼ to ¾ inches in diameter) and depositing it on the surface. The cores are subsequently disintegrated by dragging with a steel mat or other mechanical means. The core-aerifier is much more effective in thatch control than spikers, due to the larger opening it makes through the thatch into the soil. It also mixes some soil on the surface with the thatch material.
3. Vertical mowers or thinners consist of a wide variety of machines that differ in size, power, spacing between tine or blades, adjustment for depth of penetration, amount of thatch removal and amount of damage or tearing of the lawn. They have revolving shafts with tines or blades that may be classified into the following basic types:

   Spring tines—more commonly known as power rakes. This type tends to comb through the lawn lifting out thatch material. It is most useful in preventative thatch control where there is no excessive build-up of thatch.

   Swinging blades—perhaps one of the more common types that is readily available, primarily because of its low maintenance costs. This type removes thatch by the impact of the swinging blades on the thatch layer in somewhat of a beating action. It is capable of penetrating thicker and denser layers of thatch than the spring-tine type, but it also is somewhat limited in this respect because of the swinging blade. The swinging blade tends to swing back when it encounters the resistance of some of the thicker and denser layer of thatch. Another weakness of many of the swinging-blade type dethatchers is excessive damage to the living

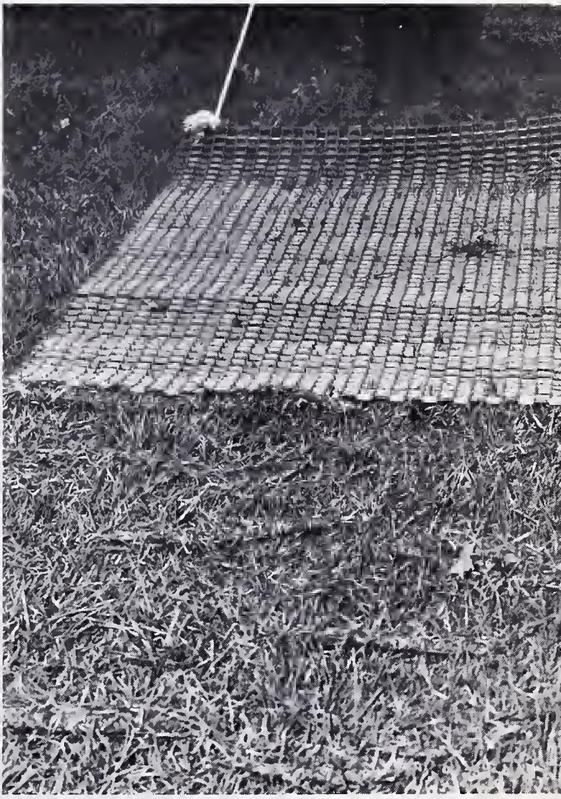
Hand rake specially designed for removing thatch on small lawn areas.

A dethatcher equipped with straight fixed blades mounted on revolving shaft.

lawn grasses. This is particularly true of the machines with a spacing between the blades of less than 1½ inches.

Straight fixed blades—could be classified as a slicing or grooving machine because of the action of its blades. The blades spaced one or more inches apart tend to cut through the thatch layer and in the process displace thatch material and deposit it on the surface of the lawn. Among all of the many types available, dethatchers with the straight-fixed blades are the most useful for curative control procedures as well as for lawns consisting of the creeping type of lawn grasses.

Within the various basic categories of machines, many variations can be found. While all of the dethatchers have some degree of usefulness in removing thatch material in preventative control, only a limited number have features that make them useful and effective in curative control procedures. The machine with the revolving straight-fixed blades, that is adequately powered and capable of adjustment to penetrate through the thatch layer without causing serious damage to the existing lawn, will provide the best results in contending with thatch problems. ♦



A steel drag mat. When dragged over a dethatched area, soil is filtered back in lawn but thatch remains on surface.

Rutgers University

Weeds in turf are generally the result of a low-quality or injured grass stand . . .

WEED CONTROL IN LAWNS

J. M. Duich

THE basic source of weeds is the soil which contains a tremendous quantity of seed in the dormant or resting state. They are brought to the surface through annual freeze-thaw cycles in northern areas, and through well-meant mechanical practices of turf de-thatching and aerification. Every load of good topsoil contains millions of weed seeds.

Others are allowed to reproduce through seeds on the original site, or are introduced from surrounding areas by wind, water, birds, vehicles and people. Relatively few are contained in commercial grass seed of a reasonable quality. When there is space in a lawn area, they are most ready to compete for light, moisture, nutrients and—more space.

Of the thousands of weed species in the U.S., constant mowing eliminates all but a few dozen. Those remaining are the turf weeds—able to persist and usually produce seed at less than the mower-cutting height. Living as annuals or perennials, they may begin their life cycles during all seasons except the cold of winter.

Let's Reflect First

In conjunction with all lawn-cultural practices, the weed control chemicals are management tools. Due to the successful development of many chemicals, we perhaps rely too heavily on weed killers as a panacea for our turf and other weed problems. Of major concern today is the misuse of chemicals, and the possible abuse of both our plants and environment. We can only justify the continued use of chemicals if they are handled in a prescribed manner. Reasonable intelligence and common sense are a must!

The Environmental Protection Agency is continuously setting both use and safety standards for all pesticides. Compliance by manufacturers and formulators results in the issuance of a label—the *same label* present on every form of herbicide commercially available to you. It is up to the ultimate consumer—including those who are lawn-tenders—to read the labels and observe all necessary precautions and safe use of chemicals. The alternative to proper consumer compliance will be restricting the use of chemicals to professional applicators, meaning the loss of the pleasures as well as economies of lawn care for many home owners.

Procedures

A successful, safe and economical weed-control program requires consideration of the following:

1. *Identification of the weeds present*[1] and possible causes for their predominance. Weeds themselves can often forecast the latter. Knotweed is considered the indicator of compacted soils, whereas clover, unless desired, is a reflection of poor-fertility level—particularly in nitrogen content. Crabgrass requires a high-light intensity and is favored by an open turf. Conversely, shading by a denser turf or higher cutting height grossly inhibits its emergence.

2. *Timing of chemical treatments.* This necessitates knowledge of a chemical's mode of action, susceptibility of weeds to treatment, and the chemical's relation to normal maintenance practices.

Chemicals vary considerably in their killing method from working in the soil to being applied on leaves, and from killing

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[1]Suggested identification reference: H. E. Jaques. *How To Know The Weeds.* Wm. C. Brown Company, Dubuque, Iowa.

germinating seeds, selective plants, or everything! Equally important is the growth stage at which weeds can most easily be killed with least harm to desired plants.

It is as senseless to chemically kill dandelions just after they have opened their cottony seed balls to the winds, as it is such annuals as crabgrass and knotweed just prior to a killing frost. Control measures in general should be avoided during high temperatures, droughty conditions, and windy days—if spraying. Most weeds are easily controlled during periods of active growth.

Reseeding of turf areas can also be greatly affected by time of chemical application. There are definite waiting periods prior to seeding, and following the emergence of seedlings. One specific chemical can even be mixed with the grass seed and kill adjacent crabgrass as it germinates.

3. *Turf grass tolerance to chemicals.* Unfortunately, not all turf grass species, even within a geographical area, have an equal tolerance to weedkillers. Therefore, it is necessary to have a reasonable knowledge of grass types to avoid injury. Bluegrass-red fescue combinations are most common in nothern areas, with the bluegrasses appreciably less susceptible to chemical injury. In the South, St. Augustine grass is more prone to injury than Bermuda grass.

4. *Proper chemical choice and application.* The most frustrating task is the choice of chemical, and the time and method of application. One can first be assured that today's chemical labels are unprecedented. They contain *complete* information on all aspects of herbicide use.

Chemicals

Herbicides vary in their mode of action (behavior) and formulation type. The latter makes it possible to apply materials in more convenient or economic manner. In certain cases they are restricted to or best applied by professional applicators.

Herbicides are formulated in various ways for convenience and safety of application. The most economical way to apply weedkillers is with a sprayer of some type. It is essential that the method of application deliver a relatively uniform spray over the turf area to avoid injury.

Many herbicides for turf use are formulated on a dry carrier, which allows uniform application with a fertilizer-type spreader to avoid wind-drift problems. Combinations containing several herbi-

Table 1. Herbicide Treatments for Seedbeds Prior to Planting

Chemical	Effect	Timing	Remarks
cacodylic acid	contact herbicide; kills surface vegetation	5-7 days before seeding (or sodding)	spreader or spray; safe on tree roots; spot-kill of perennial grass weeds
paraquat	contact herbicide; kills surface vegetation	2 days before seeding	spray; safe on tree roots; spot-kill of perennial grass weeds
dazomet	fumigant; kills seeds, seedlings, soil diseases and nematodes	2-4 weeks before seeding	professional application only unless labeled for home garden use
metham	fumigant	1 week before seeding	"
vorlex	fumigant	4 weeks before seeding	"
methyl bromide	soil sterilant; kills plants, seeds, diseases and nematodes	1 week before seeding	"

cides and other pesticides are available and are more economical only if all ingredients are necessary. Care should be taken that fertilizer-herbicide combinations are restricted to lawn use. Inadvertent use in gardens and flower beds can result in plant kill. The label recommendation rate should be adhered to closely.

Pre-plant seedbeds (Table 1). New seedbeds and weed-infested lawns can be treated to kill all existing vegetation and soil-borne weed seeds. Cacodylic acid and paraquat will kill all surface vegetation on contact. They will not, however, destroy weed seeds in the soil or underground plant plants. They have the advantage of allowing reseeding of desired grasses within one week. They are useful for lawn renovation.

The remaining chemicals in Table 1 are fumigants and sterilants. They essentially kill all plants, seeds, diseases and insects

Table 2. Herbicide Treatments for Newly Seeded Turf

Chemical	Effect	Timing	Remarks
bromoxynil	kills broadleaf weed seedlings on contact	10 days after grasses emerge; until weeds have 3-5 leaves	spray; earliest herbicide on seedling turf for broadleaf weeds
siduron	kills crabgrass and other annual grasses as they emerge	during or immediately after seeding or reseeding	spreader or spray; not on Bermuda grass and certain bents

Table 3. Herbicides for Controlling Annual Grass Weeds—Established Turf

Chemical	Effect	Timing	Remarks
A. Preemergence treatment—apply before weeds germinate:			
bandane	crabgrass	early spring	for spreader; safe on young turf grasses
benefin	crabgrass & other annual grasses	early spring	for spreader; can injure fine fescue, bent, dichondra
bensulide	crabgrass & other annual grasses	early spring	for spreader or sprayer; can injure Bermuda grass; safe on bent
DCPA	crabgrass & other annual grasses	early spring	for spreader or sprayer; may injure fine fescue *& bent in drought*
siduron	crabgrass	early spring to early summer	for spreader or sprayer; not on Bermuda & certain bents
B. Postemergence treatment—apply after weeds germinate:			
AMA, CMA, DSMA, MAMA, and MSMA	annual grasses—crabgrass, dallis. Also nutsedge and sandbur	early to mid-summer	for spreader or sprayer; moist soil and less than 80°F; repeat treatments at 10 days; not on St. Augustine and centipede; may injure fine fescue
C. Spot treatment—kills annual and perennial grasses non-selectively			
amitrole and dalapon	kills all grasses	during active growth	spray; kills grasses in treated area; one month to reseed or sod

to an approximately 6-inch depth. Unless one is most knowledgeable in their use, it is strongly suggested that applications be made by professional applicators.

Newly seeded turf (Table 2). Young broadleaf weeds emerging with grass seedlings can be readily controlled with bromoxynil. This chemical is only effective on young weeds containing up to 3-5 leaves. All other broadleaf weedkillers should not be used for 6-8 weeks after grass emergence.

Siduron represents the ultimate in herbicide seedbed selectivity to date. It can be applied the day of seeding and will kill crabgrass and several other summer annuals as they emerge, without injury to desirable turf grasses. This chemical cannot be used on Bermuda grass, but is useful to deter Bermuda.

Annual grasses (Table 3). Two basic methods are available for crabgrass and related summer annuals; preemergence and postemergence control. Preemergence chemicals must be applied *prior* to known emergence date of annual weeds. In the north, for example, application dates fall in between forsythia and lilac blooming. This class of chemical persists for approximately 90 days, and kills crabgrass as it germinates.

With the exception of the aforementioned siduron, grasses should not be reseeded during this period. The preemergence materials have the advantage of requiring only one application for highly effective control.

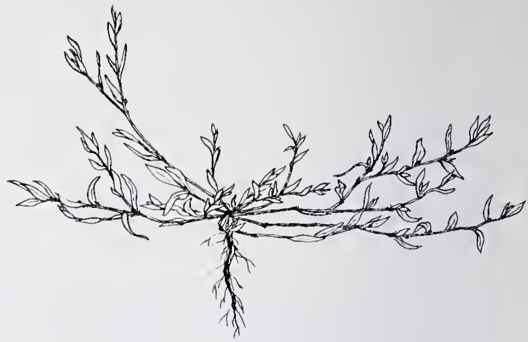
Postemergence chemicals are applicable following the emergence of annual grass weeds. Multiple applications are necessary with older weeds, requiring up to four treatments. To reduce injury and discoloration to permanent grasses, care should be taken to have adequate soil moisture and to avoid temperatures above 80° F.

Perennial weedy grasses. The most difficult weeds to control are the perennial grasses such as tall fescue, bentgrass and quackgrass. Selective control without injury to desired lawn grasses is nearly impossible. Control is practically limited to spot treating with such grass-killing herbicides as amitrole and dalapon. On a large lawn, the cure may be worse than the problem!

Broadleaf weeds (Table 4). Among the most common and successfully used her-

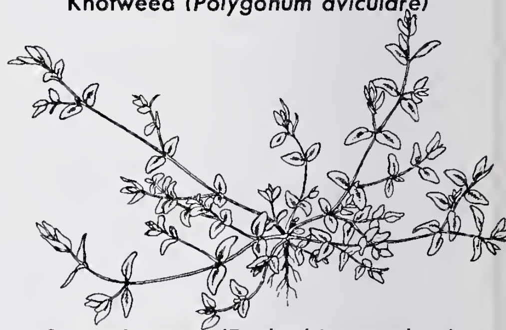
2 MAJOR LAWN WEEDS (*Left*) The dandelion is an example of a broadleaved weed with a persistent taproot and the means of spreading its seeds far and near. (*Right*) Crabgrass, an annual. Less of a lawn problem since the advent of the preemergent chemical control siduron.

Annual bluegrass (*Poa annua*)



Knotweed (*Polygonum aviculare*)

Purslane (*Portulaca oleracea*)



Spotted spurge (*Euphorbia maculata*)

Goose grass (*Eleusine indica*)

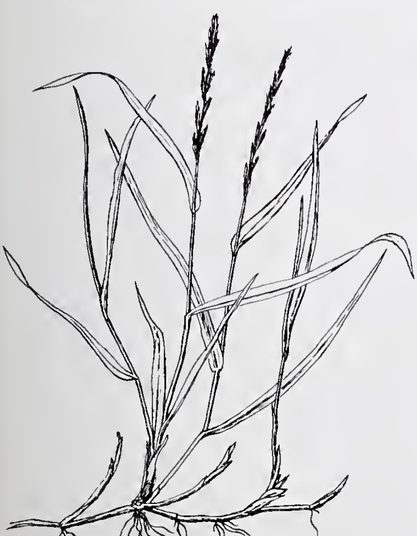
Broadleaved plantain (*Plantago major*)

Ground-ivy (*Glecoma hederacea*)

Mouse-ear chickweed (*Cerastium vulgatum*)

Heal-all (*Prunella vulgaris*)

Common chickweed (*Stellaria media*)



Quack grass (*Agropyron repens*)

Buckhorn plantain (*Plantago lanceolata*)

12 COMMON LAWN WEEDS

bicides are the ones available for the control of broadleaf weeds. These materials are also referred to as the hormone type. They are most effective when applied to the foliage because they move within the plant. Best control is obtained when weeds are actively growing.

Most notable in this group is 2,4-D which controls the majority of lawn weeds, such as dandelion and the plantains. Dicamba, mecoprop and silvex are most useful for the harder to kill broadleaf weeds. Although they can be used alone in specific cases, most combination weedkillers contain 2,4-D plus one or two of the others for single application control of practically all broadleaf weeds. These chemicals are available as sprays, aerosols, and granular forms for distribution by spreaders.

The mode of action of dicamba differs in that it can be taken up by both weed leaves and roots. Since it is more mobile in the soil with water movement, dicamba should not be used in areas over tree and shrub roots. Therefore, use caution to keep this chemical outside the dripline of woody plants.

The broadleaf weedkiller can be used both spring and fall when both weeds or grass are most actively growing. Since most broadleaf weeds occupy substantial surface area, control applications should take place in conjunction with turf fertilizer applications. This enables the dead-weed voids to be filled in more quickly by the lawn grasses.

When annual grass weeds, such as crabgrass, are known to be a problem, it is best to control the broadleafs in the fall. Otherwise, spring- and early summer-germinating grass weeds will readily grow in the voids left by dead broadleaf weeds.

The chemical control of weeds can be very successful and rewarding. It is but one step in the culture of lawn grasses. Additionally, it cannot be overemphasized that one must not only *read*, but *study* the label directions—both at the time of purchasing and then prior to mixing and using weedkillers. ◆

Table 4. Herbicides for Controlling Broadleaf Weeds in Established Turf

Chemical	Effect	Timing	Remarks
2,4-D	most broadleaf weeds	active weed growth during spring & fall	for spreader or sprayer; use minimum water to wet; avoid drift and contact with trees, shrubs & flowers; not on bent & St. Augustine
dicamba	hard-to-kill broadleaf weeds—knotweed, sheep sorrel, clover, chickweed, ground ivy & henbit	active weed growth during spring & fall	spreader or sprayer; leaches—keep outside dripline of trees & shrubs; combination with 2,4-D
mecoprop	hard-to-kill broadleaf weeds—knotweed, clover, chickweed, pennywort	active weed growth during spring & fall	spreader or sprayer; safe on bent & St. Augustine; combination with 2,4-D
silvex	hard-to-kill broadleaf weeds—clover, henbit, pennywort	active weed growth during spring & fall	spray; not on bent & St. Augustine; combination with 2,4-D
endothal	veronica, clover	spring	spray; not on bent, fescue & zoysia

Each variety has its own merits, requirements, and areas of greatest usefulness

LAWN GRASSES AND MIXTURES FOR THE COOL-SEASON REGION

C. R. Funk

A DECADE of greatly increased activity in turf-grass selection and breeding is leading to the development of an impressive array of new varieties of Kentucky bluegrass, fine fescue and perennial ryegrass. A few of these varieties are beginning to appear on the shelves of garden centers, while others are still in the experimental stage. Many should be of interest to homeowners who appreciate good lawns. Thorough testing is required to determine varieties of greatest value for each region and for each type of use.

Kentucky Bluegrass

Kentucky bluegrass (*Poa pratensis*) is the most important lawn grass in most of the northern half of the United States. It is hardy, attractive and widely adapted. The development of lower-growing, more disease-resistant varieties which produce an attractive, durable, persistant turf will make this species even more useful. Blends of improved bluegrasses or mixtures of the better bluegrass and fine fescues will continue to form the basis of quality lawns throughout most of our cool climate region.

Most of the present varieties of Kentucky bluegrass can be divided into two major groups. Common Kentucky bluegrass and varieties such as 'Park', 'Delta', 'S-21', 'Arboretum', 'Palouse' and 'Kenblue' have a rather erect growth habit with a rapid rate of vertical leaf elongation, especially during the spring and summer seasons. These varieties are all highly susceptible to severe damage from the *Helminthosporium* leaf-spot and crown-rot disease, especially in humid regions where turf is mowed closely and fertilized heavily. These common-type bluegrasses are best used in areas with brighter sunlight, lower humidity and for turf receiving high cut and medium-to-low fertility. In many instances, they persist better under low maintenance than many of the improved turf-type varieties.

The improved turf-type varieties of Kentucky bluegrass, having moderately good-to-excellent resistance to the *Helminthosporium* leaf spot and crown rot disease, include 'Adelphia', 'Baron', 'Bonnieblue', 'Fylking', 'Galaxy', 'Glade', 'Majestic', 'Merion', 'Nugget', 'Pennstar', 'Sodco', 'Sydsport', 'Victa', 'Warren's A-20' and 'Warren's A-34'. Each of these varieties can produce a very attractive, moderately low-growing turf in its area of best adaptation when given proper maintenance. For greater dependability, better long-term performance and wider adaptation it is normally best to plant a blend of a number of varieties adapted to a given region. Your local Agricultural Extension Service can provide information on varieties best adapted to your area.

Fine Fescues

Fine fescues tolerate acid soils, low fertility and shade. They do best in cool climates and during cool seasons. Summer performance is not as good as that of the better Kentucky bluegrass varieties unless the fescues are grown in cool, partly shaded locations or where there are cool summers. Fine fescue lawns of excellent quality are found in England, Holland and coastal Oregon and Washington, where summers are cool.

The fine fescues are intolerant of excessive amounts of nitrogen fertilizer in hot weather. They are generally intolerant of poorly drained soils and are best adapted

to well-drained sandy soils. Dollar spot has been very damaging to fine fescues growing under conditions of moderately poor drainage in New Jersey.

The fine fescues currently showing the greatest potential for lawns can be divided into four major types. In the absence of a clear taxonomic classification, we will refer to them as Chewings, Creeping, Spreading and Hard fescues.

The Chewings, Creeping and Spreading fescues are currently included in one species, *Festuca rubra*. However, the three types are distinct in appearance, growth habit, management requirements, adaptation, breeding behavior and cytological characteristics. They should probably be classified as separate species.

The Chewings type, *F. rubra* subsp. *commutata,* is a fine-leafed, lower-growing grass without rhizomes. When mowed, plants spread slowly by basal tillering. Where summers are cool, they will tolerate rather close mowing. In northern Europe, the Chewings-type fescues are extensively used for closely mowed turf often in mixtures with bent grasses. In areas of the United States where summers are warm, it is best not to mow fescues too closely. The name 'Chewings Fescue' is from a Mr. Chewings who first sold its seed in New Zealand. Seed traced to this source has been grown in Oregon for many years and is certified under the variety name 'Chewings'. The variety 'Cascade' is equivalent to this Oregon-produced seed, having been given a special name to qualify it for international trading purposes. A number of Chewings-type fescues have been developed in recent years and some show considerable promise in tests. 'Jamestown', from the University of Rhode Island, and 'Highlight', developed in Holland, are among the best of the improved Chewings-type fescues. They can be much more competitive and persistent in mixtures with Kentucky bluegrass than the fescue varieties formerly available. This can be either an advantage or a disadvantage.

The creeping and spreading types of red fescue are both designated by taxonomists as *Festuca rubra* subsp. *rubra.* The creeping types have 42 chromosomes and are represented by 'Cumberland Marsh', 'Dawson', 'Golfrood' and 'Oasis'. They are fine-leafed, lower-growing varieties with short, thin rhizomes and give a turf similar in appearance to the better Chewings-type fescues. Some types, such as 'Golfrood', are salt-tolerant. The creeping types generally are poor seed producers. They can be seriously damaged by the dollar-spot disease in some areas. Some of the most leaf-spot resistant varieties can be found in this group.

The spreading types of fine fescue have 56 chromosomes, somewhat wider leaves, long spreading rhizomes and good seedling vigor. They don't tolerate as close mowing nor do they produce as dense a turf as the creeping or Chewings types. In New Jersey they have performed well in roadside tests and in mixtures with bluegrass varieties. 'Fortress' and 'Ruby' are representatives of the spreading-type fine fescues.

The Hard Fescues

The hard fescues, *Festuca longifolia,* are receiving considerable attention since the development and release of 'Biljart' hard fescue (Scotts C-26) in Holland. Because of the success of this new hard fescue variety, turf-grass breeders in both the United States and Europe are collecting hard fescue plants from old turf areas and initiating breeding programs with this species. The better hard fescues produce a turf comparable in texture and growth habit to the better varieties of the Chewings-type fescue but with a somewhat slower rate of vertical growth, better resistance to some diseases and better adaptation to poor soil. The hard fescues spread only by tillering and appear to be rather slow to recover from wear and other types of injury when grown in pure stands.

Perennial Ryegrass

Perennial ryegrass is a cool-season grass best adapted for permanent use in regions having relatively mild winters and cool, moist summers. Specially de-

veloped ryegrass varieties perform exceptionally well for either hay, pasture or sports turf in areas having maritime climates, such as New Zealand, the British Isles, Holland and the coastal areas of Washington, Oregon and Northern California. Ryegrasses are not as well adapted to continental climates where summers are hot or winters are very cold. In such areas, they perform well only during the cool periods of spring and fall. In the American South, the better ryegrass varieties can provide excellent winter turf.

The common or hay-type varieties of perennial ryegrass such as 'Linn' and 'Common' perennial ryegrass, have been used extensively in turf-seed mixtures. Such varieties generally produce a short-lived, stemmy, open turf which can be very difficult to mow at certain seasons.

In recent years, plant breeders have developed a number of improved turf-type ryegrasses, including varieties such as 'Manhattan', 'Pennfine', 'NK200' and 'Eton'. These turf-type ryegrasses can produce a leafy, more attractive turf with greater persistance, better density and finer texture and improved mowability as compared to the common or hay-type varieties. Varieties presently under development may show even greater improvements in attractiveness, mowability, disease resistance, and tolerance of heat and cold.

The new fine-leafed, turf-type ryegrasses are such an improvement over common perennial ryegrass in areas where they are well adapted that many people fail to recognize them as ryegrasses. They are easy to establish and will also grow on a wide range of soil types. Even though the turf-type ryegrasses are easier to mow than other ryegrasses, they can be difficult at times, especially under stress conditions of heat or drought. Frequent cutting and a sharp mower help maintain top quality.

A properly chosen blend of the best new bluegrass varieties will generally give better long-term performance than any of the new ryegrass varieties in areas of the northeastern and north-central United States where Kentucky bluegrass is well adapted. In such situations and where the slow establishment of Kentucky bluegrass is not a problem, seedings of only Kentucky bluegrass or mixtures of Kentucky bluegrass with the fine fescues should be used. This is generally the situation that exists in sod production and top-quality turf culture.

In many other situations, the quick establishment and other desirable characteristics of the turf-type ryegrasses make them extremely useful. The new ryegrasses have done exceptionally well on some sandy coastal plain soils where Kentucky bluegrass is not well adapted. They can provide temporary turf in heavily shaded areas if seeded to take advantage of the leaf-free period of late fall and early spring. The ryegrasses establish readily and if the shade is not too intense they will persist through much or all of the summer. School grounds and parks should benefit greatly from the use of good ryegrass-bluegrass mixtures. The comparatively slower rate of vertical growth of the turf-type ryegrasses should make them of value in mixtures for roadside turf where mowing is both hazardous and expensive. The improved mowability, finer texture and rapid establishment of the new ryegrasses make them especially valuable for overseeding putting greens, fairways and lawns in southern areas to provide an attractive winter turf.

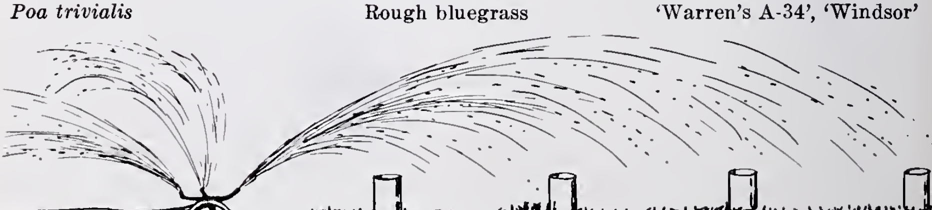
On home lawns and similar turf areas, the turf-type ryegrasses can be used in mixtures witth the better Kentucky bluegrass and fine fescue varieties to provide quick establishment. This can be particularly important where soil erosion, excessive weed competition or other factors make rapid coverage especially desirable. These improved ryegrass-bluegrass mixtures are equally valuable for overseeding or renovation of turf areas devastated by disease, summer injury or wear. In many instances, where soil and management conditions favor bluegrass, the ryegrasses will be crowded out within a year or two. In other instances, the ryegrasses will remain as a component of the permanent turf. ◆

LIST OF COOL-SEASON TURF GRASSES IN THE UNITED STATES

C. R. Funk

THE grass family (or Gramineae) contains about 620 genera including approximately 10,000 species of grass. Of all families of flowering plants, the grasses are of the greatest usefulness to man. Grasses include our important cereal grains (wheat, rice, oats, rye, corn, sorghum and millet), sugarcane, bamboo, the numerous species of our hay fields, pastures and range lands as well as the turf grasses used on lawns, parks, sports turf, roadsides and in soil conservation.

Scientific Name	Common Name	Typical Varieties
Agrostis alba	Redtop	
Agrostis canina	Velvet bentgrass	'Kingstown'
Agrostis palustris	Creeping bentgrass	'Penncross', 'Seaside'
Agrostis tenuis	Colonial bentgrass	'Astoria', 'Exeter', 'Highland', 'Holfior'
Festuca arundinacea	Tall fescue	'Alta', 'Fawn', 'Goar', 'Kentucky 31', 'Kenwell'
Festuca longifolia	Hard fescue	'C-26'
Festuca ovina	Sheep's fescue	
Festuca rubra subsp. *commutata*	Chewings fescue	'Cascade', 'Chewings', 'Highlight', 'Jamestown'
Festuca rubra subsp. *rubra*	Red fescue	'Dawson', 'Fortress', 'Illahee', 'Pennlawn', 'Rainier', 'Ruby', 'Wintergreen'
Lolium multiflorum	Annual ryegrass	'Florida Rust Resistant', 'Gulf', 'Magnolia'
Lolium perenne	Perennial ryegrass	'Eton', 'Linn', 'Manhattan', 'NK100', 'NK200', 'Norlea', 'Pelo', 'Pennfine'
Poa annua	Annual bluegrass	
Poa compressa	Canada bluegrass	'Canon'
Poa pratensis	Kentucky bluegrass	'Adelphi', 'Arboretum', 'Baron', 'Bonnieblue', 'Cougar', 'Delta', 'Fylking', 'Kenblue', 'Majestic', 'Merion', 'Newport', 'Nugget', 'Palouse', 'Park', 'Pennstar', 'Prato', 'Sodco', 'Sydsport', 'Victa', 'Warren's A-20', 'Warren's A-34', 'Windsor'
Poa trivialis	Rough bluegrass	



Method to determine amount of water a lawn receives.

QUESTIONS AND ANSWERS ON ZOYSIA IN THE NORTH

Q. Is there a practical way to prevent zoysia from invading nearby flower and shrub borders?
A. This is not easy! Chemical edging can be dangerous to plant material. Aluminum barriers can be of considerable help but must be set at least a foot deep and even then some of the rhizomes may creep underneath or crawl over the top of the barrier. Hand weeding—before the zoysia makes too much headway into the unwanted area—seems to be the only other alternative.

Q. Are the green dyes recommended for coloring zoysia lawns in the South (see page 72) just as useful for northern zoysia lawns?
A. Yes, indeed. Also overseeding with one of the new varieties of fine-textured ryegrasses is another technique. Steps include mowing the lawn close in mid-September; removing the clippings; dethatching with a machine as described on page 70; seeding, raking and then keeping the area moist with frequent watering.

Q. How many seasons after sprigging a zoysia lawn in the North can I expect total coverage?
A. Sprigging will require at least two years for complete coverage—longer if the sprigs or plugs are planted more than 6 to 8 inches apart and weeds are not controlled.

Q. Under what special conditions would you recommend planting a lawn of zoysia?
A. In any situation where the major interest or need for a lawn is during the summer season, such as a summer home at the seashore.

Q. What is the northern hardiness limit of zoysia?
A. Northern New Jersey—southern New York and into southern New England in the coastal areas.

Q. My established zoysia lawn is very vigorous but is filled with thatch. What would happen if I burned it over in very early spring while it is still brown? Would this get rid of most of the thatch? Would it seriously harm the zoysia?
A. Burning can rid the lawn of thatch if it is in a dry condition, but the practice is not recommended—for a number of reasons. 1. There is a ban against open burning in certain states and localities. 2. There is danger of fire getting out of control. It would be better to follow the procedures recommended for dethatching on page 48.

Q. How can I destroy an established zoysia lawn so I can plant a standard mixture of 'Merion' bluegrass and a fescue?
A. Rototilling or any other type of tillage would not be totally effective. Chemical eradication with a grass killer such as dalapon is necessary. Application of dalapon as a spray is made when the zoysia is actively growing; repeat in 10-14 days if kill is not complete. Wait at least one month, then strip off most of the dead zoysia. Prepare soil for seeding or sodding.—*Henry W. Indyk*

MOWING HEIGHT FOR LAWN GRASSES

Grass	Mowing Height (in.)
Bahia	2
Bentgrass, Colonial	½-1
Bermuda	¾-1
Carpet	2 -2½
Centipede	1 -1½
Kentucky bluegrass	1½-2
Red fescue	1½-2
Ryegrass	1½-2
St. Augustine	2 -2½
Tall fescue	2
Zoysia	¾-1½

Choosing the best grass for your needs . . .

LAWN GRASSES FOR THE SOUTH

Glenn W. Burton

MOST people in the South are looking for a lawn grass that will stay green the year around. Unfortunately, those grasses that grow well during the summer turn brown after the first freeze and stay brown most of the winter. In zone 10 (see U.S.D.A. map), these grasses often remain green year around. In much of zone 7 tall fescue, properly managed, will be green throughout the year. In the rest of the South, the grasses that are green during the winter become dormant, turn brown, and usually die during the summer. Thus, for most of the South both a warm-season and a cool-season grass are required to provide a green lawn all year.

Domestic (annual) ryegrass is generally the best species for a green lawn in winter, but because it dies out in the summer, it must be planted each fall. If you want a green lawn for winter, broadcast ryegrass seed evenly in the fall and work it down in contact with the soil. Then water to hasten germination, fertilize freely, and mow regularly for best results. *Note*: New improved ryegrasses provide a more attractive and longer-lasting lawn than annual ryegrass.

All Turf Grasses Must be Mowed

Not surprising is a frequent request from new home owners for a lawn grass that requires no mowing. Although some grasses require less than others, none will make a satisfactory turf without some

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. . . AND THEIR MAINTENANCE

V. B. Youngner

ZOYSIA and several other grasses become dormant or semi-dormant during the winter in most areas. This dormancy, important to the home owner because it means that the grasses lose their green color, occurs both in the North and in mild climates with the advent of cool weather, as these particular grasses grow best when air and soil temperatures are high.

The principal warm-season grasses are Bermuda grass, zoysia grass, St. Augustine grass, carpet grass, Bahia grass and centipede grass. They all spread by either rhizomes, stolons or both. Their creeping habit is an important characteristic in determining specific maintenance practices. Dichondra, although not a grass, is a low-growing sod-producing plant popular for home lawn use in California. The culture of this morning-glory relative differs in several respects from that of the true grasses.

Although warm-season grasses are used for lawns over much of the southern half of the United States (and zoysia is quite common in northern regions these days), their care will vary to some extent with the climates of the region. This is especially true for the timing of some practices such as fertilization and renovation.

Fertilization

All lawn grasses require regular feeding if they are to make an attractive turf, but rates and times of application are not necessarily the same for every species and variety. Of the three principal nutrients, phosphorus and potassium are relatively easy to maintain in adequate supply as they are not readily leached from the soil and are needed in relatively small amounts compared to nitrogen. Nitrogen, on the other hand, must be carefully

mowing. There are a number of good lawn grasses from which you may choose. Unfortunately, none of them are perfect. For best success, select a grass that fits the environment in which it must be planted. (The information included in the Table will be helpful.) Carpet grass (*Axonopus affinis*), for example, will winterkill in Kentucky and Tennessee, whereas Kentucky bluegrass (*Poa pratensis*) will usually not survive the long, hot summers experienced in the carpet grass belt. If the soil is poorly drained, carpet grass will do better than Bermuda grass (*Cynodon dactylon*) unless you are willing to go to the extra expense of putting in drain tile. Bermuda grass would be a poor choice for use under shade trees.

By changing the environment, you can grow species that otherwise could not be successfully grown. For example Bermuda grass will make excellent turf on the poorest sands when they are heavily fertilized, and carpet grass will grow in dry sites if it can be watered frequently.

If you are a busy home owner who must neglect your lawn, you will do well to choose a grass that makes a satisfactory turf with a minimum of mowing and care. Centipede grass (*Eremochloa ophiuroides*) is a good choice.

Bermuda Grass

Bermuda grass will stand more drought than any of the other species listed here. Few grasses will tolerate as much wear as Bermuda grass, and as a grass to grow in association with ryegrass for year-around lawns, it is unsurpassed.

There are now a number of improved Bermuda grass selections that make a greener, denser, more beautiful turf than common Bermuda grass. Although they must be established from sprigs, their rate of spread permits wide spacing and

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applied and accurately regulated. Nitrogen deficiency will lead to poor color and weak growth; excessive amounts may cause immediate damage or produce soft growth readily injured by disease organisms or foot traffic. Most forms of nitrogen are not held securely in the soil and much may be lost through leaching or other processes.

Since the amount of nitrogen needed will vary with climate as well as kind of grass, the requirement is most easily expressed as pounds of actual nitrogen (N) per 1000 sq. ft. of lawn area per month of growing season. See Table No. 1.

Thus, if your lawn is of Bermuda grass, which grows and remains green for about six months in your locality, you should provide from 6 to 9 lbs. of actual nitrogen for each 1000 square feet during that time. If your soil is heavy the lower figure should be satisfactory; if your soil is light and sandy, the higher amount may be required. Rainfall and irrigation will also modify the amount of nitrogen needed—with heavy rainfall or watering, more of the nitrogen will be lost by leaching.

A large part of the root and rhizome growth occurs in the spring and fall when top growth may be slow. Therefore, fertilization at these times is particularly important. During the warmest part of summer nitrogen may stimulate excessive top growth, so it is advisable to provide only enough of it to maintain satisfactory color. Frequent light applications (¼ to ½ lb. of actual N/1000 sq. ft. every two weeks) of soluble, readily available nitrogen material, such as ammonium nitrate, in the fall will delay the onset of dormancy and maintain better green color. Simi-

Table No. 1

Kind of Grass	*lbs. N to 1000 sq. ft. a month*
Bermuda	1-1½
Zoysia	¾-1
St. Augustine	½-1
Bahia	½-1
Centipede	¼-½
Carpet	¼-½
Dichondra	½-1

keeps the cost low.

'Tiflawn' ('Tifton 57') and 'Tifway' ('Tifton 419') are splendid for football fields and playgrounds. In the Southwest 'Texturf 10' is superior for heavy use. 'Tiffine', 'Tifgreen', 'Tifdwarf' and 'Tifway' are triploid hybrids between common Bermuda grass and African Bermuda grass (*Cynondon transvaalensis*). They have narrower leaves and make finer turf than either 'Tiflawn' or common Bermuda grass. Since they are completely sterile and shed no pollen, they will not offend hay fever victims. 'Tiffine' is light apple green. 'Tifgreen,' primarily for golf greens, makes a beautiful dark green lawn but is more costly to maintain because of its greater susceptibility to the sod webworm (grass moths, Crambidae) and mole cricket (Gryllotalpidae). 'Tifdwarf', a dwarf mutant of 'Tifbreen', is tops for golf greens and makes a beautiful lawn when given the extra care it demands. 'Tifway' is very dark green and appears to be fairly resistant to insects and diseases. Other triploid hybrids, less widely grown, are 'Bayshore', 'Everglades', and 'Ormaond' for Florida; 'Santa Ana' and 'Royal Cape' for California; 'Midway' and 'Tufcote' for part of zone 6; 'Pee Dee' for South Carolina; and 'Sunturf,' which is sometimes damaged by rust.

Armyworms (*Pseudaletia unipuncta*), even when not controlled, inflict only temporary damage and defoliate the grass for but a very few days each year. Delayed mowing leaves Bermuda grass lawns looking brown for several days; thus they should be mowed regularly and frequently for best appearance. If you have a flower border around a lawn, particularly annuals, remember that Bermuda grass is a greater pest in flower beds than other grasses mentioned here.

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larly, such applications in early spring will accelerate the appearance of new growth and good color. However, where winters are cold, late fall applications of nitrogen are not advisable because they stimulate a soft succulent growth, which can be more susceptible to freezing.

Centipede and carpet grasses should be given only sufficient nitrogen to maintain satisfactory color. High nitrogen levels seem to induce iron deficiency chlorosis, a yellowing of the leaves caused by lack of iron which can occur under some conditions to all turf grasses. Such chlorosis on these and other grasses can be corrected by applications of ferrous sulfate, iron chelates or other iron-containing products sold for this purpose. Iron deficiency chlorosis may also occur in warm-season grasses when the soil is cold and wet but the air temperature is warm enough for leaves to grow.

Avoidance of over-fertilization of dichondra is especially important. Too much nitrogen will produce long leaf stems and thus a tall, loose turf. Subsequent mowing will remove a high proportion of the leaves, resulting in an unsightly stubble and exposed soil. Frequent, very light applications of a soluble nitrogen fertilizer or the use of a good slow-release product are recommended to avoid this problem with dichondra.

Applications of lime to raise the soil pH may be required in the humid Southeast where acid soils are common. Lime is seldom needed in California and the arid Southwest. Lawns of centipede and carpet grasses should not be limed, as they grow best on acid soils.

Mowing

Although mowing is what makes a stand of grass into a turf, it is not generally beneficial to the grass. Severe mowing—too close, too frequent, or removal of too much growth in a single cutting—will restrict root growth and reduce turf density. Increased susceptibility to injury from heat, disease and traffic may also result from severe mowing.

Carpet Grass

Carpet grass seed is usually inexpensive and a lawn of it is not costly to establish. In low, wet areas, carpet grass will make a reasonably good turf. It is resistant to most insects and diseases and requires little expenditure for fertilizer. It grows best on acid soils and becomes chlorotic (a result of iron deficiency) and dies on neutral or alkaline soils. Never lime the soil in which you intend to plant carpet grass. Carpet grass produces long, slender seed stalks most of the summer. These heads give the lawn a ragged appearance whenever mowing is delayed. Reel-type lawn mowers will not cut carpet grass clean unless it is mowed frequently enough to remove the flowering heads before they reach their full height.

Centipede Grass

Centipede grass is highly resistant to chinch bugs (*Blissus leucopterus leucopterus*), armyworms, and most of the insects and diseases that attack lawn grasses. It is quite susceptible, however, to a comparatively new soil-borne insect commonly called "ground pearl" (Margarodidae). The ground pearl is a tiny, spherical insect about the size of a pinhead, which feeds on the grass roots through a long, hairlike mouth part. It is yellow or pearl-colored and is covered with a waxy coating that protects it from most insecticides. This insect causes the grass to wilt and often to die during dry periods. Moderate fertilization and frequent watering are the only practical control measures now available. Centipede grass is subject to iron deficiency when overfertilized, overwatered, or limed. Spraying with copperas (iron sulfate) at the rate of 2 ounces per 1000 square feet or applying it dry in the fertilizer will usually correct this deficiency. If the defi-

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Prostrate creeping grasses, Bermuda grass for example, can usually tolerate closer and more frequent mowing than upright growing varieties. Clipping these creeping grasses at too great a height or too infrequently will produce a loose fluffy turf and a rapid accumulation of thatch.

Recommended mowing heights and frequencies for good turf appearance and vigorous growth are shown in Table No. 2.

A reel mower is preferred for Bermuda, zoysia and St. Augustine grasses because a neater and smoother appearance will result. Bahia grass and carpet grass produce numerous tall and tough seedheads which cannot be removed with a reel mower. Therefore, a rotary is generally preferred for these species.

Particular care must be exercised to avoid scalping dichondra. Since it is not a grass and produces leaves on the end of slender stems, scalping will leave only a leafless stubble, the turf will be severely weakened, and recovery will require a long time. If a dichondra turf is accidentally scalped, it should be immediately given a top-dressing of compost or similar organic material to prevent sunburn of the delicate surface stolons. A light application of fertilizer will speed recovery. It is usually best to remove clippings from Bermuda grass- and St. Augustine-grass lawns. Their vigorous growth produces a large amount of material which may smother new growth and increase thatch accumulation.

Watering practices as recommended for all lawns should be followed for the

Table No. 2

	Mowing Height	*Mowing Frequency*
Kind of Grass	*Inches*	*Days*
Bermuda	½ to 1	5-7
Zoysia	¾ to 1½	7-14
St. Augustine	1 to 2	5-7
Carpet	1 to 2	7-10
Centipede	1 to 2	10-14
Bahia	1½ to 2½	5-7
Dichondra	¾ to 1½	10-14

ciency is not corrected, the grass may die out completely.

Centipede grass decline, a dying-out of grass in spots, appears to be due to the destruction of much of the root system by a complex of soil-borne organisms. Generally the grass dies for lack of water. Over-fertilization that increases the susceptibility of centipede grass to Rhizoctonia brown patch and thatch build-up accentuate the problem. No more than 6 pounds of 16-4-8 (or its equivalent) per 1000 square feet per year, generally applied in the spring, are recommended for centipede grass. Water as needed to prevent wilting, and remove or open up thatch with a vertical mower or aerifier to prevent loss of rain from run-off. Centipede grass makes a dense turf that chokes out weeds. It is easy to mow even when mowing has been delayed for several weeks. If sprigs are to be planted, check the soil from which they were dug, making sure there are no ground pearls in it. The hazard of introducing ground pearls into the lawn with the planting stock can be avoided by planting seed. If you plant seed, remember to water frequently while the plants are small. They will tolerate little drought during early development. 'Oaklawn' is a variety of centipede grass reported to be tolerant to drought and temperature extremes.

St. Augustine Grass

St. Augustine grass (*Stenotaphrum secundatum*) has long been popular for shaded lawns in the deep South. Unfortunately, it is susceptible to several diseases that damage it severely during prolonged rainy periods. It is also very susceptible to injury from the chinch bug, a tiny, sucking insect that attacks the leaves and stems. Many St. Augustine grass lawns

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warm-season grasses (see pages 17 to 21). Only a few special considerations are necessary for this group of grasses. Bermuda grasses are naturally deep-rooted and drought-tolerant. Watering should be deep to encourage this characteristic. Zoysia grasses are also deep-rooted but are less tolerant of overly wet conditions than Bermuda. Good drainage should be provided when the lawn is established so any excess water will drain away quickly.

Bermuda, zoysia and St. Augustine grasses are highly tolerant of poor-quality saline waters. Dichondra, on the other hand, will be injured by relatively low salinity levels. It should not be used where only poor-quality water is available.

Thatch Control and Aerification

All warm-season grasses produce some thatch, the layer of dead, undecomposed grass leaves, stems and roots that accumulates on the soil surface. St. Augustine, Bermuda and zoysia are especially rapid producers of thatch. When thatch accumulates on these grasses, mowing often results in scalping—the removal of all green growth to expose the discolored thatch below. Mowing frequently, and at the recommended height, will retard the rate of thatch accumulation but will not prevent it.

Usually some form of mechanical thatch removal is required. On small lawns a specially designed rake may be used, but on larger lawns a power-driven vertical mower or renovator is more practical. The vertical mower should not be set to cut into the soil surface. In heavily thatched turf it may be necessary to repeat the dethatching operation two or more times, working in cross directions and gradually lowering the knives until the desired amount of thatch is removed.

Thatch removal may be as frequent as once a year for Bermuda and St. Augustine grasses, less often for the slow-growing zoysia and centipede. Thatch removal on warm-season grasses should be

have been killed by this insect, particularly in the unshaded areas where it prefers to feed. 'Scott's 1081' St. Augustine grass reportedly has improved chinch bug tolerance. Chinch bugs can kill St. Augustine grass, so investigate all wilted areas for their presence and apply recommended control measures at once. Even then, delayed treatment may come too late to save the grass.

St. Augustine grass grows best on neutral or slightly alkaline soils. Most southern soils need some lime. Have your soil tested for lime requirement to avoid overliming. Many St. Augustine lawns, particularly in Texas, have been destroyed by a virus disease called St. Augustine grass decline SAD). 'Floratam', a variety resistant to SAD, should be planted where the disease is known to occur. Other named varieties of this highly variable grass are 'Bitter Blue', 'Floratine', and 'Roslawn'.

The Zoysia Grasses

The zoysia (*Zoysia* spp.) grasses make excellent turf when managed properly. They are resistant to most insects and diseases and once established, make a very dense, weed-free turf. They are attractive, dark green, tough enough to withstand fairly heavy foot traffic, and are highly shade-tolerant. They are also more frost-tolerant than the other summer-growing grasses and often remain green longer in the fall.

They turn brown in the winter, however, and make such a dense turf that it is almost impossible to grow winter grasses, like ryegrass, with them. The zoysia grasses spread very slowly, and thus are costly to establish. They are more susceptible to drought injury than Bermuda grass, so require more watering during dry periods. They are tough and difficult to mow, particularly when mowing is

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performed in the spring, summer or early fall when warm weather permits quick recovery. At least one month of warm weather is required for recovery of zoysia. Recovery will be accelerated by an application of fertilizer and careful watering to prevent drying of exposed stems, stolons or rhizomes.

Raking or vertical mowing every 4-6 weeks during the summer, if practical, may eliminate the necessity for the drastic treatment described above. Performing the operation this frequently permits removal of the thatch as it accumulates, without seriously disturbing the growth or destroying the appearance of the turf.

Overseeding for Winter Lawns

In a large part of the southern and western United States, many lawn owners wish to maintain a year-round green lawn. Since warm-season grasses lose their green color and become dormant with the onset of cool fall weather, it is usually necessary to overseed them with cool-season grasses for winter color. This is a frequent practice on common or hybrid Bermuda grasses because they recover quickly in the spring and can compete well with the winter grasses. Overseeding is usually not recommended for the slow-growing zoysia grasses, as they are often injured by the practice and spring recovery can be greatly delayed. It is also a questionable practice on St. Augustine grass.

Step-by-step Procedure

The procedure is as follows: 1. Mow lawn at usual height or lower if possible. 2. Remove thatch with a vertical mower or renovator. 3. Rake off all debris. 4. Mow remaining grass closely. 5. Sow the desired cool-season grass. (See Table No. 3). 6. Rake seed into soil surface. 7. Although not required, a light top dressing of an organic compost may speed establishment. 8. Keep the soil surface moist until seedlings emerge. 9. Fertilize with nitrogen as needed.

Annual ryegrass is the most commonly used cool-season grass for overseeding. It

Lawn Grasses for South—Cont.

delayed. When improperly managed, they, particularly Manila grass (*Z. matrella*), build up a tough, dense mat that is difficult to dispose of. 'Meyer' zoysia makes a better turf than ordinary zoysia (Japanese lawn grass, *Z. japonica*), but both are coarse and, in most of the South, are generally inferior to the narrower-leaved *Z. matrella*. 'Emerald' zoysia is a *matrella*-like hybrid that is superior to the *Z. matrella* selections with which it has been compared. Zoysia sprigs should be planted 6 inches apart in 6-inch rows for reasonably quick coverage (usually several months).

Z. japonica seed, harvested in the Orient, can often be purchased. Plants from this seed vary considerably and are coarser than those of 'Meyer.' Plant at least 8 oz. of seed per 1000 square feet to get a satisfactory stand.

Bahia Grass

Bahia grass (*Paspalum notatum*) is a coarse pasture grass extensively used as a turf grass on roadside shoulders in zones 9 and 10. Here is has become the dominant species, crowding out weeds and other grasses. In Florida, Bahia grass, easily established from seed, has provided a sod where other lawn grasses have failed. Before planting Bahia grass, however, remember that it is coarse, grows faster than other lawn grasses, and must be mowed every 4 to 5 days all summer to keep its tall seed heads down. Also, it will crowd out other grasses. Bahia grass will

Continued

Maintenance—Cont.

germinates quickly, producing a green lawn in two weeks or less. However, annual ryegrass seed always contains a small percentage of perennial types. Often these perennial plants will persist well into the summer competing with the warm-season grass and their coarse sprawling clumps detracting from the appearance of the lawn.

Other cool-season grasses that may be used for winter turf are Kentucky bluegrass, creeping red fescue, rough-stalked bluegrass and highland bentgrass. The new fine-leaved perennial ryegrasses have made excellent winter turf in many regions. Although these grasses may persist through one or more summers, depending upon climate, they generally are quite evenly distributed and blend well with the Bermuda grasses. Therefore, even though these species develop more slowly, they may be preferred to annual ryegrass. Mowing should be at 1-1½ inches for all cool-season grasses except the bentgrasses, which may be mowed at ½ inch.

Table No. 3

Species or Variety	*lbs. of Seed per 1000 sq. ft.*
Annual ryegrass	8-12
Kentucky bluegrass	3
Creeping red fescue	5-8
Highland bentgrass	2
Rough-stalked bluegrass	2-3
Perennial ryegrass ('Manhattan,' 'Pennfine' and other fine-leaved strains)	8-10

Color for Winter Lawns

Although it may seem strange to many people, the use of green dyes sprayed on dormant warm-season grasses has become an accepted practice today. Several companies have developed high-quality products for this purpose that are a natural grass-green, will not wash or rub off, and will not fade for many weeks. They are not toxic to children or pets.

Colorants may be used on any dormant warm-season grass that is brown. They are especially useful on zoysia and St. Augustine grass, which do not lend themselves well to overseeding. As formulations differ, the user should follow the manufacturer's instructions carefully. Avoid spraying walls and sidewalks, as most colorants will leave a long lasting stain on these structures. ◆

PERENNIAL LAWN GRASSES FOR THE SOUTH

Species	Leaf texture	Adaptation zones*	Shade tolerance	Soil preference	Fertilizer required	Propagation method	Care required Mowing	Care required Other
Common Bermuda Grass	medium to fine	7,8,9,10	poor	well-drained	much	seed (1 lb:1000 sq. ft.)	much	medium
Hybrid Bermuda Grass	fine	7,8,9,10	poor	well-drained	much	sprigs	much	medium
Carpet Grass	medium	9,10	fair	wet sandy	little	seed (1 lb:1000 sq. ft.)	medium	little
Centipede Grass	medium	8,9,10	fair	little	very little	seed (4 oz:1000 sq. ft.)	little	little
St. Augustine Grass	medium	9,10	very good	sandy loam	medium	sprigs	medium	much
Zoysia	fine to medium	7,8,9,10	good	little	medium	sprigs or seed	medium	medium
Bahia Grass	coarse	9,10	fair	little	little	seed (2 lb:1000 sq. ft.)	very much	little
Tall Fescue	coarse	7	good	little	medium	seed (2 lb:1000 sq. ft.)	much	medium

* See U.S.D.A. map on inside back cover.

spread by seed to other areas, and the seeds will lie dormant in the soil for years.

Because of these charcteristics, Bahia grass cannot be permanently replaced with a different grass should this be desirable at some later date. 'Argentine' and 'Paraguay' Bahia grasses are much coarser but produce fewer seed heads and are easier to mow than the 'Pensacola' variety usually planted along road shoulders.

Tall Fescue

Tall fescue (*Festuca arundinacea*) is a coarse, cool-season pasture grass, well adapted to zones 6 and 7. It is much coarser than the fine-leaved fescues generally used for turf, but is a more dependable turf grass in much of zone 7. Here it is the dominant species planted along road shoulders. It is easily established from seed and if seeded at recommended rates (see page 73), mowed at a height of 2½ to 3 inches, and watered as needed, it will make a very attractive, wear-resistant green turf almost year around. Although it produces seed stalks that require frequent mowing, these usually appear for only a short time in late spring. 'Kentucky 31' is the variety most commonly planted for turf. 'Alta' is generally rated slightly below 'Kentucky 31' in density and persistence. Numerous new lawn-type varieties are presently being tested.

Establishing Vegetatively-Propagated Grasses

Other than tall fescue, all perennial lawn grasses listed in the Table on page 73 are stoloniferous and can be propagated vegetatively. For best results we suggest that you:

1. Establish the desired grade and prepare the soil well as for a garden. Apply lime if soil tests indicate its need. Broadcast 15 to 20 pounds of complete fertilizer, such as a 10-10-10, per 1000

OVERSEEDING FOR WINTER COLOR
1 Remove thatch from Bermuda grass with a vertical mower.

V. Gibeault

2 Mow the remaining grass very closely and then remove all debris from lawn.

square feet and thoroughly work it and the lime into the top 6 inches of soil.

2. Plant sprigs only when the soil is moist. Spring and summer plantings are usually best. Fall and winter plantings should be over-seeded with 3 to 5 pounds of domestic ryegrass per 1000 square feet to help control erosion. Be sure to keep the ryegrass mowed at a height of about 1 inch to reduce competition with the grass developing from the sprigs in the spring.

3. Plant fresh, pure (certified is best) sprigs as soon as possible. Do not let them wilt or dry out. Set the sprigs as deep as possible in a perpendicular position in the soil so that about 1 inch of the tip leaves is left above the soil surface.

One of the best planting methods is to push the basal end of the sprig into the soft soil with a thin (1/8 inch) stick until only the tip leaves are left protruding. Then remove the stick and firm the soil around the sprig by stepping on it. A 12-inch piece of 30/6 inch- by 1½ inch-strap iron (with a "V" cut in the end), bolted to the end of a 5-foot stick, will enable you to plant sprigs in this manner from a standing position. Plant on 12-inch centers for rapid coverage. Water the sprigs immediately after planting and keep the soil moist by watering lightly once or twice daily until the sprigs begin to grow. Sprigplanting machines are available and may be rented from the nursery supplying the sprigs.

4. Control weeds for rapid lawn establishment. Herbicides, such as 2, 4-D (1 to 1½ lb per acre) or simazine (1 to 2 lb per acre), applied immediately after sprigging and before weeds start to grow, will usually give good early weed control. Be sure that the proper rate is applied and that chemicals do not get on shrubbery or other susceptible plants. Mowing weekly at a height of 1 inch as soon as weeds begin to grow will help to control weeds and favor establishment of grass.

For additional culture and care of these lawn grasses, see page 76. ♦

3 Remaining turf should be open and 1 inch or less high before overseeding.

4 A good spreader is needed for even distribution of seed. Final step is to keep lawn moist until grass emerges.

Calendar for building and maintaining

AN ATTRACTIVE WARM-SEASON GRASS LAWN

Victor B. Youngner

THE following schedule outlines the principal steps in lawn building and maintenance with warm-season grasses. (Detailed explanations of each step are presented in other sections in this Handbook.) The times suggested for the various steps are quite broad and should be adapted as necessary to each specific climate and situation. In mild climates appropriate times may be earlier in the spring and later in the fall than those for the same procedures in a colder climate.

Establishing the New Lawn

March—April

1. Remove large stones and scraps of concrete, wood, or other debris. Work the soil deeply and establish the rough grade.
2. Install the sprinkler system and test it for a good distribution pattern.
3. Mix an organic soil amendment and lime into the soil to a depth of at least 6 inches, if they are needed. Cultivate or use other methods to destroy weeds.
4. Prepare the final seedbed and apply a complete fertilizer high in phosphorous and potassium, working it into the top 2 inches of soil.

May—June

1. Seed, sprig, plug or stolonize, as appropriate, the selected warm-season grass variety. Keep soil surface moist until the new grass growth has fully emerged and a root system has become established.
2. Gradually increase the interval between waterings, allowing the soil surface to dry, but maintaining adequate moisture below.
3. Mow to the proper height for the variety as soon as the grass has grown ½ to 1 inch above that height.

July—September

1. Mow turf as above. Apply nitrogen fertilizer as needed.
2. Selective weed killers may be used when necessary after the new grass is well established.

September—November

1. Apply soluble nitrogen fertilizer in light, frequent applications to help maintain color.
2. Overseeding with cool-season grasses is usually not recommended during the first year unless the turf is dense and well established. When the turf goes off-color a green colorant may be used.

Maintaining the Established Lawn

January—April

1. Apply soluble nitrogen fertilizer as the soil begins to warm in the spring to stimulate new growth. One application of a complete fertilizer should be made in the spring unless soil tests indicate it is not needed.
2. If the lawn was overseeded with a cool-season grass in the fall, reducing the mowing height will assist the warm-season variety to dominate.
3. Preemergence herbicides for crabgrass control should be applied at this time.

May—June

1. Fertilize with nitrogen as needed.
2. Watch for chinch bug and brown patch disease in St. Augustine grass and apply recommended control chemicals if required.
3. Herbicides for control of broadleaved weeds and established crab grass will be most beneficial if applied now.
4. Mow at least once per week at the recommended height. Vertically mow heavily thatched lawns.

July—August

1. Aerify and vertical mow to control thatch and water regularly.

2. Mow frequently at the recommended height.

3. Watch for summer diseases and insects on all grasses. Flea beetles may be especially damaging to dichondra. Control sprays should be applied as soon as a pest is detected.

4. Lawns should be watered thoroughly during prolonged dry periods.

September—October

1. Renovate and overseed Bermuda grass lawns with cool-season grasses for winter turf, or apply colorants as soon as warm-season grass loses its color.

2. If lawn is not to be overseeded or colored, light and frequent applications of soluble nitrogen fertilizer will prolong green period.

3. Apply lime if required.

4. Preemergence herbicides for control of annual cool-season weeds should be applied at this time.

November—January

If the lawn has been overseeded with cool-season grass, mowing and fertilization practices should be those needed by the winter grass. In arid regions, occasional watering may be required, even if the grass is dormant, to prevent dessication of crowns, roots and rhizomes. ◆

From J. R. Watson

This attractive warm-season lawn is unmarred by unsightly above-ground watering equipment because an under-ground sprinkling system has been installed. The system has an important advantage in that it saves time for busy home owners.

Calendar for building and maintaining

AN ATTRACTIVE LAWN IN THE NORTH

Ralph E. Engel

A TIME schedule on making and maintaining a lawn helps get the work done at the right time with a minimum of frustration.

Building the New Lawn

Late June and July

1. Complete plans for late summer and fall seedings.
2. Destroy weeds and other old vegetation in late July in preparation for late summer seeding or sodding.
3. Sodding is successful with proper watering.
4. Poor season for seeding.

August and September

1. Apply lime about August 1.
2. Mix a complete fertilizer into soil in second or third week of August.
3. Prepare a good seed bed, one that is firmly and gently contoured.
4. Sow seed in late August, especially that of Kentucky bluegrass if it is used alone.
5. September is second only to late August as a good seeding time.

October—Early December

1. Excellent period for sodding.
2. Seeding can be satisfactory if the area is mulched or is free from possible winter erosion.

Late December—February

1. Sodding can be done if soil is not frozen and moisture is adequate.
2. Seed may be sown into frozen "honeycombed" soil or natural mulches of grass or weeds.

March—April

1. Lime, fertilize and till for spring seedings if you plan to start a new lawn now.
2. Prepare final seed or sod bed if dry enough.
3. A very good season for sodding.
4. Seed in March rather than April if possible.
5. Use siduron according to instructions if crabgrass is a serious problem.

May—Early June

1. Sodding is quite satisfactory now if you attend to watering.
2. Poorest time of year for seeding. Best chance for success is on sites with weed-free seed beds and where water can be applied when needed.

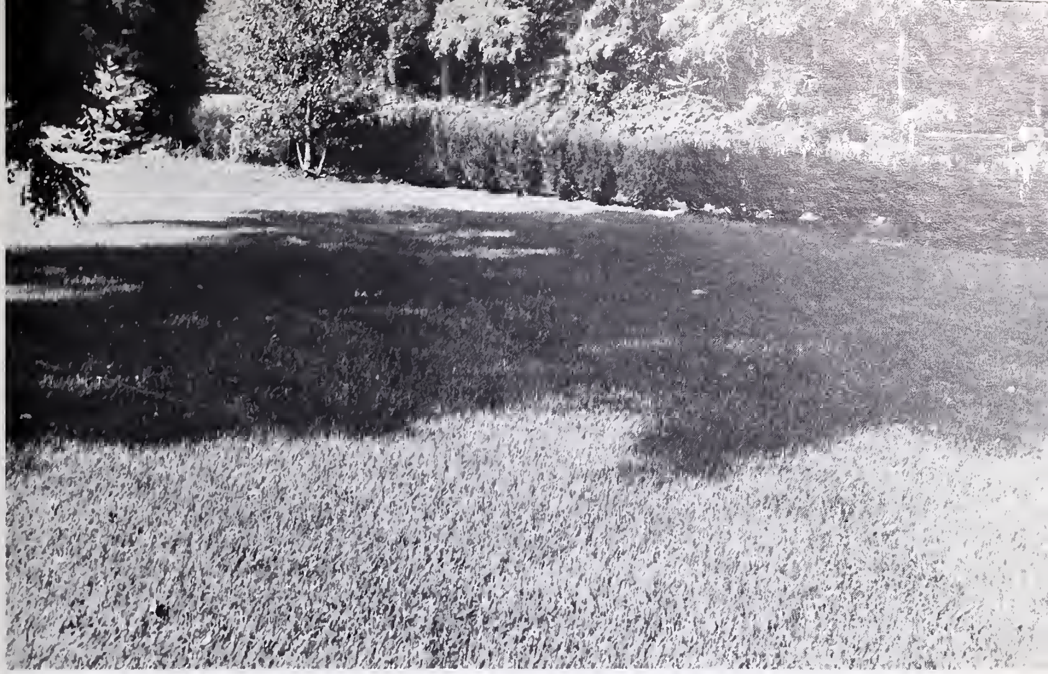
Maintaining the Cool-season Grass Lawn

September—October

1. Fertilize in cool weather of September; water fertilizer into soil.
2. If crabgrass was not checked in August, a DSMA herbicide can still be useful in early September.
3. Sow seed in bare areas in late September.
4. Dandelions, plantain and buckhorn can be controlled with 2, 4-D as spot treatment or general spray with proper precautions for nearby plants.
5. De-thatching on Kentucky bluegrass lawns is best during this period.
6. Patch difficult bare areas with sod in October.
7. Ground limestone can be applied if needed.
8. Check for Japanese beetle grubs in the northeastern United States and use an appropriate insecticide as necessary.

November and Early December

1. Re-fertilize if September-October fertilization did not give adequate growth.
2. Ground limestone can be applied if needed and not done earlier.
3. Patch any bad spots with matching sod.



Marjorie J. Dietz

Grass remains the choice of most home owners as the most attractive and practical ground cover for most situations even with its maintenance problems.

4. A snow mold fungicide might be used on lawns in northern areas where this disease is common.

January and February

1. Apply ground limestone if needed and not applied earlier.
2. Protect heavily used areas from foot traffic in very wet or wear-susceptible periods.

March and April

1. Roll in late March if soft spots in the soil are raised in winter.
2. Apply a moderate application of fertilizer in late March to Kentucky bluegrass lawns that need spring growth.
3. Ground limestone can be applied if earlier applications have not been made and if needed.
4. Apply 2, 4-D for dandelion control as soon as this weed shows significant leaf growth.
5. Apply preemergent crabgrass herbicides where the presence of this weed justifies. The ideal time of treatment varies according to locality. April is best for most temperate climates.
6. Mow as soon as significant growth develops. Most Kentucky bluegrass lawns require mowing every 3 to 7 days in April and during the good weather of late spring.

May and June

1. Mow often. Grass grows quickly in cool, moist weather and it is wise to avoid severe, infrequent cutting.
2. Fertilization is generally less desirable than in August, September, October, and early spring. If used, apply at half rate.
3. Watering is usually not necessary, except in very dry periods and in dry climates. Deep but infrequent watering should be sufficient now.
4. Spot-treat scattered dandelions with 2, 4-D.

July and August

1. Be on the alert to water turf carefully in prolonged hot dry periods.
2. Watch for sod webworms and chinch bug and use an appropriate insecticide if necessary.
3. Use DSMA in August for eontrol of abundant crab grass.
4. Watch for damage from young Japanese beetle grub infestations in August. ♦

Lawn maintenance can be eased with

THE RIGHT EQUIPMENT

J. R. Watson

MACHINERY and equipment required for proper lawn care should be selected on the basis of the size and layout of the area, taking into consideration what maintenance will be handled by the home owner and what, if any, by a professional lawn service. Home owners who take care of their own lawns, in addition to a mower, need a fertilizer spreader (which may double as a seeder when necessary), aerator, watering equipment, and certain more specialized items, such as dethatcher, edger-trimmer, sprayer, sweeper, cart or wheelbarrow and roller. Some of these items, such as a roller or dethatching machine, can be rented.

Mowers

Grass cutting is undoubtedly the most time-consuming part of lawn maintenance. Also, good mowing practices are perhaps the most important single factor contributing to the well-groomed appearance so desirable in a lawn. For these reasons the selection and care of the mower are particularly significant.

Selecting the Mower Mowers are available in varying widths and with numerous features. Requirements of a good mower are:
easy starting, maneuverability, easy adjustment, durability, and adequate horsepower for the size of the mower and the usage expected. In addition, the ready availability of parts and service is an important consideration.

The width of the mower chosen will be determined by the size and layout of the lawn area. The diagram shows the width of mower needed for efficient cutting of lawns of various sizes. The diagram does not take into account terraces, trees, shrubs, flower beds, etc., which may be present. Large open expanses have requirements entirely different from those of small broken-up areas.

Two basic types of mowers are available—the reel and the rotary. Choice will be governed by the particular duties expected from the mower. Each type has certain advantages and certain limitations which need to be carefully considered when the selection is made.

Reel-type mowers are always recommended for the cutting of formal and semi-formal lawns. The cutting action of the reel is like that of a pair of scissors. Reels, when sharp, properly adjusted and in good operating condition, give a clean, even cut and leave the lawn with a smooth, well-groomed appearance.

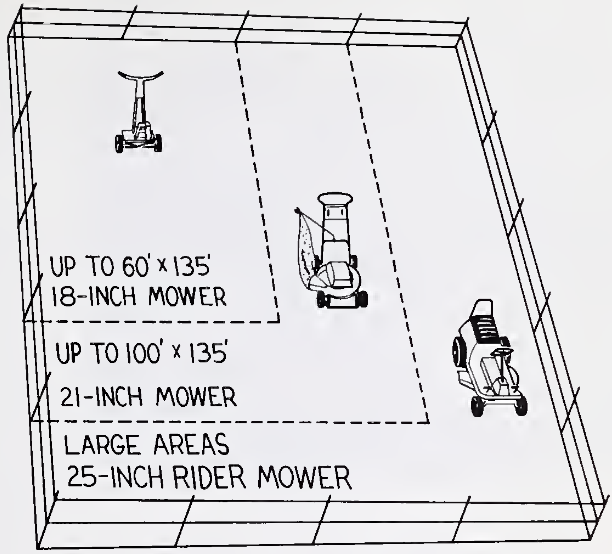
Practically all reel-type power lawn mowers are self-propelled. Other desirable features to look for in reel mowers are:

1. Handles that can be easily adjusted for height to suit the individual operator.
2. Handles which stand up or fold up for easy storage.
3. A range of cutting height adjustment from ½ to 2 inches.
4. Large sectional rollers—these improve handling qualities and reduce damage to good turf.
5. Safety guards over chains and other moving parts.

For bentgrass and fine-leaved Bermuda grass lawns, the reel should have at least six, preferably more, blades. This gives a closer frequency of clip (the distance between cuts as the mower progresses) which eliminates a riffled or corrugated appearance of the lawn. Reel mowers are not satisfactory on poorly graded or uneven-surfaced lawns.

Rotary mowers are more versatile and popular. In addition to handling most lawns, they are adapted to rough conditions and are necessary for areas where control of grass, tall-stemmed weeds and

Choosing a mower depends on the size of the lawn. The smaller the area, the less need there is for a wide-cutting mower.



other unruly vegetation is more important than a well-groomed lawn.

The rotary cuts by "impact" similar to the cutting action of a scythe. For this reason, a sharp, properly balanced blade is necessary to avoid a ragged tearing of the grass blade. Cutting with a dull blade generally results in a graying and subsequent browning of the leaf tip.

As more and more women take over lawn chores, self-propelling of rotaries becomes a desirable feature. Other features to be considered when selecting a rotary mower are:

1. Safety: to protect fingers and toes, the blade tip should be covered as it sweeps through the critical arc at the back of the mower; if there is a bagging attachment, the engine should shut off automatically when the bag chute is removed; the mower should have a deflector bar that deflects objects down into the grass and keeps careless hands and feet away from the blade; and a safety shield to protect the operator against deflected objects or his own inattention, should be fitted to the rear of the mower.

   Additionally, all controls should be in one place, within easy reach of the operator, away from the blade; and all operating instructions right in front of the operator.
2. Blade should be firmly mounted to insure that it will never loosen up during operation.
3. Handle should be adjustable to suit operator.
4. Handle should stand up for easy storage.
5. Cutting height should be easy to adjust and have a range of 1 to 3 inches.
6. Blade should be of the "suction lift" design to create air turbulence. This, coupled with "wind-tunnel" housing gives a better cut and produces a vacuuming action for spring cleaning of lawn areas.
7. Wheels should be large enough to permit easy operation.

Sometimes the home owner may find it advantageous to own both a reel and rotary mower. This is particularly true if a mountain or lake shore lawn is to be maintained, in addition to the home lawn; or if a portion of the lawn is maintained as a formal garden or used as a putting or bowling green.

Some home owners prefer to do their grass cutting sitting down. Riding mow-

Shredders of varying capacities have become popular in home gardens. They shred leaves and other garden debris which can then be composted.

ers and lawn tractors have transformed lawn maintenance, eliminating the drudgery and saving time as well as effort. A quarter-acre (10-12,000 sq. ft.) is considered the minimum size for a rider or tractor.

A riding mower does only one job—cut grass. The cutting unit is permanently attached and can be either rotary or reel, with the rotaries dominating as they do in the walk models. The horsepower of the rider is less than that of a tractor, with consequent savings in cost. But for versatility in yard care, consider the tractor. Not only can it be fitted with mowing units, but it can also clear away snow, plough, till, fertilize or—with cart attachment—carry topsoil, tools, or virtually anything.

Caring for the Mower Lasting and satisfactory operation of the lawn mower may be obtained by following a routine program of care. The first step is to carefully read the service manuals (engine and mower) supplied with the machine. Become completely familiar with the location of all bearings and moving parts which require oil or grease. Keep a clean supply of oil and gasoline on hand. Change crankcase oil as often as recommended in the service manual. Check and tighten all loose nuts regularly.

After each operation, brush away dust and grass clippings which may lead to overheating if permitted to accumulate around the engine; fill the tank with gasoline; oil moving parts with grade of oil recommended by the manufacturer; and store in a clean dry space.

At least once a year, take the mower into an authorized service shop for sharpening and replacement of worn parts. For winter storage, drain the fuel tank and crankcase, and lightly brush all metal parts with oil.

Fertilizer Spreaders and Seeders

A spreader is almost essential for uniform and even distribution of fertilizer and seed. Hand application of fertilizer (and haphazard mechanical application as well) often results in alternate light and dark streaks in a lawn.

Fertilizer spreaders vary in width, ease of operation, accuracy, and construction. As a general rule, a 24-inch spreader is adequate for lawns of 5,000 to 10,000 square feet. Smaller and larger sizes are suggested for lawns smaller than 5,000 square feet and larger than 10,000 square feet respectively.

Spreaders should have large wheels—at least 10 inches in diameter and wide enough to facilitate easy pushing. Accu-

rate, easily operated control mechanisms and calibrated settings for different materials and seed insure uniform distribution at the desired rate of application. A good spreader will have a durable force-feed agitator which also aids uniform distribution.

It is important that taking apart a spreader and cleaning the agitator and bottom side plates be easily done. Preferably, the side plates should be of a corrosion-resistant material. After each use, the spreader should be thoroughly cleaned, dried and oiled. Most fertilizer materials are corrosive and, unless these steps are taken, may cause excessive rusting or corrosion which will reduce the life and operating ease of the spreader.

Cultivators (Aerators)

The cultivation of turf grass by the use of hollow-tined spoons and spikers is a necessary step in a sound lawn maintenance program. It will not mar the beauty of the lawn, but will improve movement of water into and through the root zone and permit the deep placement of lime and fertilizer. These factors in turn promote superior root growth which results in a more vigorous, healthy turf.

Small hand forks with two or three hollow tines are satisfactory for correcting and improving small localized hard spots where grass does not grow very well. To aerate the entire lawn with this type of tool, however, is entirely too laborious and time consuming. Large power-driven units, such as are used on golf greens, may be rented from a local garden supply center; or a lawnkeeping service may be employed to custom-aerate the lawn.

Spikers or spike disks may be used to advantage when seeding becomes necessary.

Watering Equipment

Automation has also promised an end to another toilsome lawn chore—hand watering, with the attendant shifting of above-ground hose-end sprinkling devices. There are now available a number of underground automatic sprinkling systems whose controllers can be pre-set for any desired watering program. Once set, the system functions even when the home owner is away on vacation. Costs of these systems have been brought within budget range of most home owners through pre-engineered components, the use of plastic pipe (which has the added advantage of being freeze-proof), and great advances in the technology of sprinkler heads and valves. (Some do-it-yourself kits are available. One point: Be sure your water pressure is adequate to operate the system.)

An important advantage the automated system has over hand-watering is that the former applies water uniformly and at a rate and manner which the soil can absorb. In general, a sprinkler should deliver about ½ inch of water per hour and disperse it uniformly throughout the pattern. If a greater volume of water is discharged, the soil may be unable to absorb it and wasteful runoff and erosion can occur.

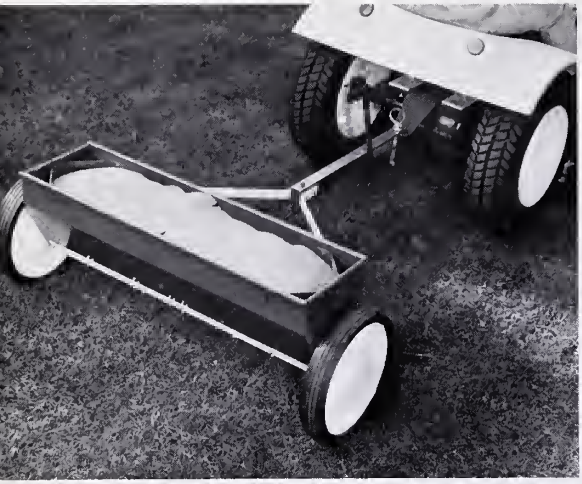
The inside diameter and length of hose play an important part in proper water application manually. The larger the diameter, the larger will be the volume of water carried, irrespective of pressure. Operating pressures reduce as hose length increases—no matter what the faucet pressure. And a small, long hose may prevent satisfactory performance of some sprinklers.

Edgers and Trimmers

Edging around flower and shrub beds and along walks and driveways, combined with trimming of grass adjacent to buildings and fences, gives the lawn area an appearance of finished grooming.

At one time, trimming and edging was perhaps the most tedious and time-consuming chore associated with lawn care. Hand shears, hoes, spades, and hatchets were often employed in an effort to attain a finished appearance. In recent years, a wide array of equipment has become available for this purpose. Mechanized trimmers and edgers have reduced the time and effort required to achieve the desired appearance.

(*Continued*)



Riding mower with fertilizer or seed spreader attachment and reel mower *(right)*.

Edgers and trimmers are available as independent and combination units. Some are hand operated and some powered—electric (cordless trimmers have recently been introduced) and gasoline driven. Powered units are recommended if extensive edging and trimming are necessary. Operating manuals should be consulted for care and maintenance of these units.

Sprayers

Sprayers are necessary for the proper application of chemicals to control weeds, diseases and insects. They may also be used to apply liquid fertilizer.

Small knapsack sprayers (2- to 5-gallon capacity) are ideal for localized spraying and are generally satisfactory for the application of herbicides and insecticides on lawns up to 5,000 square feet. Power-operated sprayers of 10 or more gallons capacity have a much wider range of adaptation. They are ideal for spraying lawns, shrubs, and ornamental trees, as well as gardens.

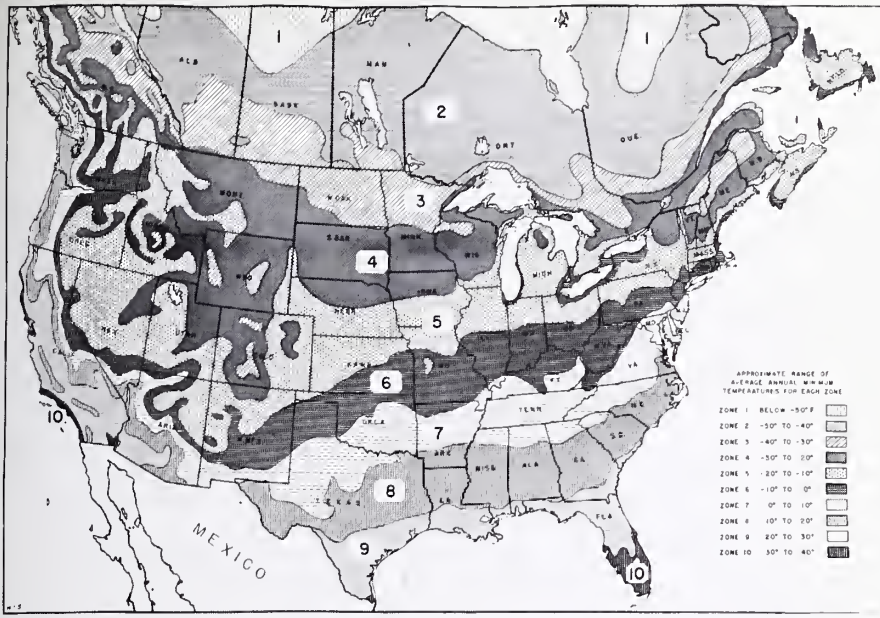
Sprayers should be constructed of materials that resist corrosion and of a design that permits easy disassembly for complete cleaning. Extreme caution must be exercised in cleaning after using 2, 4-D and similar materials. This is especially true if the sprayer will be used to apply insecticides in the garden or on flowers, or trees at a later date. Authorities almost unanimously recommend an extra sprayer to be used only for the application of 2, 4-D. Whenever using control chemicals, manufacturers' directions should be carefully read and followed. And all chemicals should be handled with caution.

Debris Management

Many communities now ban the open burning of lawn and garden debris, including leaves. Because of this and the spiraling costs of trash removal and the growth of interest in recycling and ecology, a new group of powered equipment has been developed—the debris handlers. The shredder takes in leaves, grass clippings, stalks, weeds and small twigs and reduces them in volume by 80 to 90 per cent. This debris is shredded to compact size for easy bagging or conversion to natural fertilizer through composting.

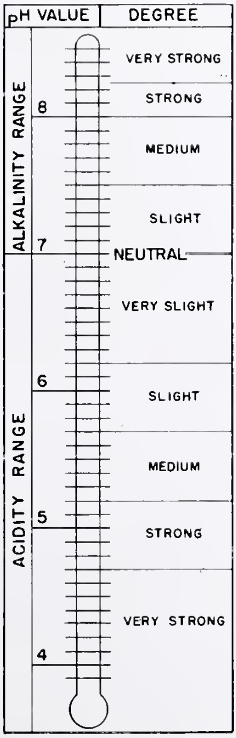
The lawn vacuum is an outdoor clean-up machine with a carpet-cleaner head that rids lawns of small rocks, bottle caps, twigs and branches, or even broken glass. It can clean a quarter-acre lawn of grass clippings or other debris in less than an hour.

The blower produces a high-velocity jet stream of air that sweeps walks and driveways clean and piles leaves and grass clippings in rows for easy collection. A hose attachment converts it to a vacuum that sucks up the debris. ♦



UNITED STATES DEPT. OF AGRICULTURE ZONE MAP

Acidity or alkalinity of soils as shown on the pH scale, the "thermometer" used to indicate acidity or alkalinity.



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PLANTS & GARDENS

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- Collecting & Storing
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SUMMER
1973

NEW SERIES

Vol. 29 No. 2

AMONG THE CONTRIBUTORS

ELIZABETH ALEXANDER, Montauk, New York, has an interest in plant dyeing which stems from family traditions dating back to Colonial times.

MARY ANN BEINECKE, Nantucket, Massachusetts, Director, Nantucket School of Needlery.

NOËL BENNETT, Gallup, New Mexico, studied with Indian weavers and dyers while her physician husband was working at the Navajo Reservation. She is co-author with Tiana Bighorse of *Working with the Wool*, a book on Navajo rug weaving.

EDNA BLACKBURN, Caledon East, Ontario, Canada, is in charge of the Albion Hills Farm School, where she teaches spinning, weaving and dyeing.

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JEAN K. CARMAN, St. Lucia, Queensland, Australia is an active home dyer and member of the Handweavers and Spinners Guild of Victoria.

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WILLI and FRED GERBER, Ormond Beach, Florida, are a botanical husband-and-wife team. After teaching at Cornell University, they became interested in ferns (*Platycerium*), succulents, bromeliads and, ultimately, dye plants. Co-authors of numerous articles on dyeing and leaders of workshops in Massachusetts and elsewhere.

ESTHER K. HASEL, Assiniboia, Saskatchewan, Canada. A keen dyeing hobbyist who is experimenting with plants of the Great Plains.

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Copies of special issues of PLANTS & GARDENS are available as Handbooks. For a list of topics see back cover.

Photographs by Philip B. Mullan

Above: Skeins of wool are lifted from the dyepot into a container of water of the same temperature as the dyebath as a first step in the rinsing process. Other steps of the dyeing process are shown on pages 10-12.

Left: Carrot tops being cut for dyeing. By the use of different mordants, the resulting dye colors will range from bright yellow through varying shades of greens. For information on mordants, see pages 4 and 5.

LETTER FROM THE BROOKLYN BOTANIC GARDEN

Home crafts have had a revival in the past ten years, as any fair-goer, garden-clubber or bookstore-browser quickly notices. More and more people are creating their own pottery, leather goods, patchwork quilts, candles and soaps. Weaving, crewel and macramé are "in," and a rough-and-ready ex-football player, Roosevelt Greer, has even written a book on needlepoint. The deeper meaning of this revival we gladly leave to the social "scientists" to ponder, but there is a common denominator that is obvious—the growing desire for artistic self-expression.

Horticulture is affected too, because creative individuals, often from outside the field, are looking at plants and plant parts as design elements or raw materials. The freshness that accompanies such an approach can only enrich horticulture, since it leads us to look at plants through different eyes. Queen Anne's-lace is no longer a roadside weed but a treasure in a dried arrangement. A deformed pine which would have been discarded from the nursery row a few years ago is now a jewel to the bonsai enthusiast. And the common goldenrod becomes gold to the dyer. (It has never deserved its low reputation with Americans, for in selected forms it is a first-rate, non-aggressive garden perennial, and it is a hay fever culprit only in myth.)

The interest in dyeing with natural plant materials has grown sharply since 1964 when the Brooklyn Botanic Garden's first handbook on the subject appeared. Letters, literally hundreds of them from the United States and other lands, have prompted this companion issue. Let us at this time express our warmest appreciation to Guest Editor Palmy Weigle and the international roster of Contributors invited by her to share their knowledge of the ancient art of dyeing.

One of the refreshing aspects of the revival in plant dyeing is that it cuts across age lines as well as national boundaries. At a time when much, far too much, is heard about the generation gap, it is noteworthy that young and old are taking an equal interest in this pleasurable craft. But then, the act of artistic creation recognizes no age limits.

If the Botanic Garden has helped in some way to stimulate interest in natural plant dyeing, it has in turn been stimulated by it. Several instructors have caught the "bug," and short courses for adults as well as young people are frequently offered. In this connection it is a pleasure to report that a Botanic Garden color film on plant dyeing, sponsored by the Women's Auxiliary, is in preparation. Watch for its release in the spring of 1974.

Finally, to borrow a thought from Mrs. Weigle: "Happiness is dyeing in your own kitchen!"

Frederick McGourty, Jr.

Editor

The New York Unit of the Herb Society of America has, by gift, made possible the color photographs in the centerfold of this handbook.

NATURAL PLANT DYEING

A weed in the rose garden may produce a better color in the dyebath than the rosebushes do in the garden

Palmy Weigle

IN the years since 1964 when *Dye Plants and Dyeing* was first published by the Brooklyn Botanic Garden, there has been a transition from the objective intellectual approach to natural plant dyeing to the practical desire to apply the art to one's everyday life. This new approach stems from several factors, including the resurgence of crafts as a whole, the rejection of anything that is not "natural," and the renewed interest in the environment that surrounds us.

In the workshops given at the Botanic Garden and elsewhere, and in the letters that come to us from all parts of the world with increasing frequency, it has become apparent that there are many questions still unanswered and at the same time much information to be shared. It was against this background that a complementary handbook on dyeing was conceived and it is hoped that this issue will stimulate further research.

In discussing the subject of natural dyeing or vegetable dyeing, too often it is contrasted with chemical dyeing. All dyes have a chemical make-up, just as all fibers have a chemical composition. The contrast that is intended is between those dyes that have their basis from objects found in nature as contrasted with those dyes which stem from a laboratory. Dyers throughout history have had a deep interest and a working knowledge of the part that chemistry played in achieving the colors they desired. In order to better understand the nature of the materials being used today, please turn to page 8 of this handbook for a discussion of some of the basic principles involved in natural dyeing.

It is not necessary to work in a laboratory or with highly technical equipment to do natural dyeing. The kitchen stove, the hot plate in the studio or workroom, or the open fire outdoors can give equally good results. For utensils, enamel, stainless steel or glass pans enable the dyer to bring out the true colors of the material he is using. Lined rubber gloves do help protect the hands from stains and from excessive exposure to some of the mordants.

Mordants are chemical additives that sometimes help a fiber accept a dye that it might previously have rejected. The word "mordant" stems from the Latin *mordere* which means "to bite." It has traditionally been thought that the mordants bite into the fiber to permit the dye to penetrate. From the discussion in this handbook on page 51, it appears that this may very likely be what does happen.

A detailed explanation of the various mordants will be found in *Dye Plants and Dyeing* (Brooklyn Botanic Garden Handbook) on pages 9 to 12. Some of the more common mordants found in the recipes included in this handbook are:

1. Alum (aluminum potassium sulfate), which is usually combined with cream of tartar in a ratio of 3 parts of alum to 1 part of cream of tartar.
2. Cream of tartar (potassium bitartrate), used with alum and sometimes with tin to help soften the effect of those chemicals on the fibers.
3. Tin (stannous chloride), often used as a brightening agent to make a color sharper or lighter.
4. Iron (ferrous sulfate or copperas, not to be confused with copper). In the dye plant world iron is called a "saddening" agent because it makes a color darker or duller.
5. Chrome (potassium dichromate), a bright orange substance that seems to deepen the colors achieved and to make

CHART OF COMMON MORDANTS

Common Name	*Chemical Name*	*As a Premordant in 1 Quart of Water*	*As an Additive*
		Amounts per 1 ounce medium weight 2 ply natural wool	
Alum plus Cream of Tartar	Aluminum potassium sulfate plus Potassium bitartrate	¾ tsp. alum plus ¼ tsp. cream of tartar	May be used (in same proportion as premordant) along with wool and dyestuff.
Chrome	Potassium dichromate or bichromate	1/16 of a tsp.	Occasionally used (in same proportion as premordant) as an afterbath to aid in color fastness.
Iron (copperas)	Ferrous sulfate or Green vitriol	Primarily used as an additive to darken or "sadden" a dyebath.	"A pinch"—a small amount held between 2 fingers.
Tin	Stannous chloride	More commonly used as an additive as it can make wool brittle or harsh.	To lighten or brighten a dyebath, use a pinch well dissolved in water before adding to dyebath.
Copper sulfate	Cuprous sulfate or Blue vitriol	Primarily used as an additive—gives wool a light blue or blue-green color.	¼ tsp. dissolved in water.
Vinegar	Acetic acid	1/3 of a cup	Frequently used to heighten the color of a dyebath, especially in the red color range.
Ammonia (non-sudsy, clear)	Ammonium hydroxide	Frequently used to draw color out of dye materials especially grasses and lichens.	Whether a premordant or an additive, the amount varies with the different dye material.

Chart by Mollie Harker Rodriguez

them more lasting.

6. Copper sulfate (blue vitriol), often used to help make colors in the green range as it itself imparts a bluish-green color to the fiber.

Other mordants are ammonia (the (the clear, non-sudsy household type), acetic acid or white vinegar as a substitute of salts as Glauber salts (sodium sulfate).

Are natural dyes fast or do they bleed? These are two separate questions. After a fiber has been dyed, it should be rinsed thoroughly until the rinse water is clear. In this way, all the excess dye is removed from the fiber and the color will not bleed. Then the color should be tested for fastness (see page 14). If the color does not stay, it is said to be a fugitive color because it flees from the fiber.

The general rule in dyeing is to use soft or neutral water unless the recipe specifically calls for hard water. The material to be used may be mordanted ahead of time or the mordant may be added to the dyebath. Do not subject the fiber, especially wool, to abrupt changes in temperature since this sudden change will "shock" the wool and cause it to lose some of its vitality. Use a mild soapy rinse if

P. W. Grace

Foliage of the sassafras tree (*Sassafras albidum*). The tree's roots will produce a peach-colored dye.

Juniper berries yield a dull yellow, or, with the addition of alum, brown. A khaki dye has also been reported.

tin or iron has been used as a mordant to help keep the wool from becoming brittle or harsh.

Several colors may be achieved from the same dyebath simultaneously by using skeins prepared with different mordants. To help in identifying the mordants used, attach different kinds of buttons to each skein—for example, round ones for alum and diamond-shaped ones for chrome. From experience in workshops, there does not seem to be a harmful effect from dyeing alum and chrome premordanted skeins with unmordanted skeins in the same dyebath.

Be sure to make and keep notes as to quantity, type of mordant, and other pertinent information. Always label skeins after they are dyed and rinsed, noting the dyestuff, the premordant if any, the additive if any, and the date of dyeing.

It is difficult to duplicate a color exactly, so one should dye all the yarn needed for one project at the same time. The yarn should not be crowded in a dyebath because overcrowding will produce unevenness of dye. It takes approximately one quart of dye for each ounce of yarn. To get the most from the dyestuff, the dyebath may boil vigorously if there is no yarn in the dyebath. Once yarn has been placed in the dyebath, the temperature should stay below the boiling point. Simmer it not above 190° F. In other words, maintain it at the temperature indicated by little bubbles appearing at the edges of the surface.

Other ingredients helpful for success in natural dyeing are patience, understanding and appreciation. There are dyes that can be achieved readily from gathering the plant material, making the dyebath and dyeing the yarn—all finished in a matter of a couple of hours. These are ideal dyes for demonstration purposes or for classroom work in schools or craft centers. On the other hand, some dyes may take days or even weeks to gain the best colors from them. Too often the influence of the fast pace of life today hinders the development of a beautiful dyebath. If it takes nature 30 years to bring a tree or a lichen to maturity, is 30 days too long to permit a dyebath to ferment to yield its best color?

Natural dyes that are found in the area can often give all the color the dyer desires. Carrot tops, scallions, dried larch needles or privet berries are able to give color. Don't be afraid to experiment.

If there is excitement in seeing white yarn become any one of the colors found in the centerfold of this handbook, the stage has been set for the pursuit of natural dyeing. ♦

COLLECTING AND STORING NATURAL DYE MATERIALS

Palmy Weigle

AMONG the most frequently asked questions at dye workshops are when to gather materials and how to keep them until they are used. There are of course recipes that give specific directions but there are also some general guidelines that apply to most natural dye plant material.

Gather dyestuffs when the part of the plant to be used is at its most vital stage, as described below. The colors will be stronger at that time, especially if the material is used fresh. Be sure to check conservation lists before gathering and always allow Nature the opportunity to replenish her resources.

Roots should be dug in late summer or in autumn after the plant has passed its peak flowering period. Flowers are best picked when coming into full bloom, and berries are collected when fully ripened. Leaves and bark generally give best color if gathered in spring, although bark from trees cut in autumn will still give good color.

If the material cannot be used fresh, remember that it is possible to store many types for later use. Roots, flowers, leaves and bark can be air-dried by placing them on wiremesh in a warm dry place. The wiremesh should be set up so that air can circulate below it as well as above it. The material should be turned over occasionally. In this way the moisture will evaporate more quickly and there will be less chance of mildew. After the material is thoroughly dry, it can be stored in paper bags and kept for future use.

Some berries can be dried and will produce good color. Others will not give the same colors as when used fresh. If a freezer is available, berries can be washed and then quick-frozen in plastic bags or containers. If they are measured before freezing, they do not have to thaw out before use. Berries that have been frozen properly can give very good results. Other plant parts (flowers, leaves) can be frozen if space is available.

Dyebaths can also be kept for future use. Some recipes suggest that a few days of aging or fermenting can improve a dyebath but a change of color in the dyebath often occurs—sometimes desirable and sometimes not. Storing the dyebath, covered, in a cool place or in a refrigerator is the best way to maintain its stability. Some baths can be frozen with no detrimental effect.

As with many other phases of dyeing, in the absence of specific directions in the recipe, experimentation and experience will be the dyer's greatest asset in the collection and storage of dye plant materials. ♦

P. W. Grace

Bark pattern of American sycamore (*Platanus occidentalis*). Bark of the London plane-tree (*P. acerifolia*) yields a fawn-to-brown dye when alum is added. The American species gives similar dye.

NATURAL DYEING IN THE CLASSROOM

Advice for individual beginners, too—

Mollie Harker Rodriguez

EACH TIME the Brooklyn Botanic Garden offers a course in dyeing with plant materials, among the students are a few instructors in elementary or secondary schools who have come to learn a new craft to use in their own classrooms. Their interest and inquiries, coupled with the Garden's desire to help the individual beginner in this field, have prompted us to share our experience with readers.

Dyeing with plants is an intriguing craft. Historically, plants were the sole source for the production and manufacture of all the dyes used to color fabrics until the middle of the 19th century. Today a growing number of people are rediscovering this art and are anxious to apply it to fabrics as a substitute for the aniline dyes which are now commonly used.

There are many possibilities here to stimulate the minds of young people. For children, it is learning how to use plants in the same ways as did their ancestors. Experiments in dyeing might accompany work in history or social studies courses, or complement an art course, especially if there is a field trip scheduled to a museum exhibiting tapestries or weavings. Another approach is to include dyeing methods as part of a study of the economic uses of plants.

Collecting the Plants

Collecting the plant material is done when the particular type of plant desired for use is "ready," that is, when most of the dye-producing substances are concentrated in the part you want to collect. Barks and young shoots can be gathered in early spring. Throughout spring and summer there will be leaves and flowers to use fresh or to cut and dry for later use. In autumn, berries, roots and usually some leaves are available. (See page 7).

The time of collection will alter the colors produced, as will the location of the plant in relation to sunlight, rain, wind, soil and seasonal weather conditions. All of these factors contribute to the character of the plant and therefore to the colors achieved in dyeing. Each time you dye with vegetable materials it is an experiment because every collection of plants is unique. Repeated use of the same dyestuff will prove how varied the results can be.

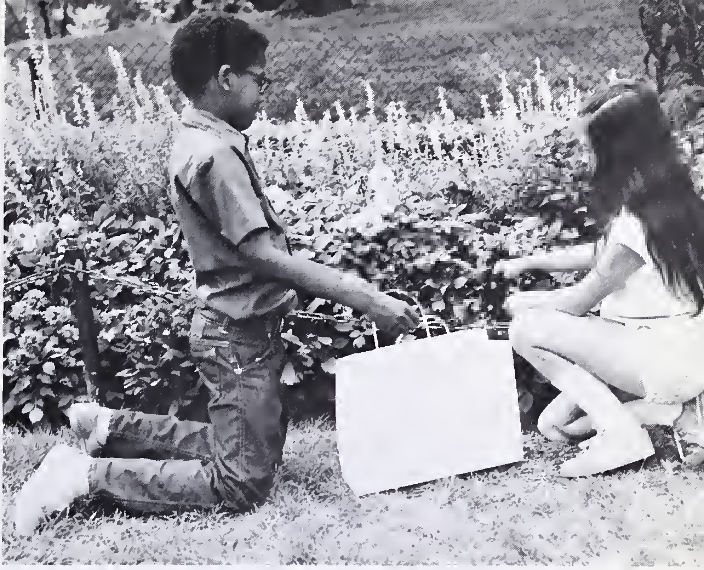
Wool

Most natural dyes yield more brilliant and lasting colors if used with wool. Wool is animal tissue and due to the substances in its cell walls, the molecules of the mordants and dyes are bound more easily to it than to the celluloid constituents of plant fibers. However, to make comparisons you might add to the dyebath a small piece of cotton sheet or jersey along with the yarn.

For classroom use, 2-ply yarn is very satisfactory because it dyes quickly and is easy to handle. If possible, natural unbleached wool should be used but bleached wool can be substituted if it is more readily available. The yarn should be tied into skeins with white cotton twine for manageability in the dyepot, as shown on page 12 of *Handbook on Dye Plants and Dyeing*. Wash the wool in several solutions of mild soapy warm water and rinse it well before dyeing.

Work with small quantities of wool such as ½ oz. dry weight skeins. They require a minimum of plant material and only a quart or so of dyebath solution. Good color samples can be obtained with

Collecting dahlia flowers to make dyes in the classroom. All flower colors can be used and the flowers can be fresh or dried. Dahlia dye colors are brilliant, ranging from chartreuse to yellows and oranges.



Photographs by Philip B. Mullan

this amount, and then if you want to use more yarn you can dye a larger amount.

In handling the wool during the dyeing process, don't "shock" it at any time by raising the temperature above 190-200° F or by subjecting it to rapid changes in temperature. Always raise the temperature of the wool gradually and lower it in the same manner, and always wet the wool before entering it into the dyebath solution.

You may tie plant material into muslin or old sheeting bags so you won't have to strain it from the dyebath before beginning to dye the wool. The bag can simply be lifted from the pan and discarded with no mess or chance of spilling and burning. Confining the plant material to the bag won't inhibit the dye from entering the solution if the bath is boiled vigorously and the bag is pressed down upon firmly with a spoon from time to time.

Equipment

A room with a sink with hot and cold water is best for dyeing. In its absence, have a couple of large pails or washpans filled with hot and cold water and an extra empty one for the rinsing operation.

Hot plates or electric burners set on asbestos pads provide the safest means for heat. If the room is equipped with bunson burners, use them with stands to hold the pots above. Keep other hot pads and holders nearby.

Stainless steel and enamel pans are very satisfactory neutral pans for dyeing. They do not in any way affect the dyebath, whereas pans of aluminum and iron alter the colors slightly and shouldn't be used unless that is the desired effect.

Wooden, plastic or stainless steel spoons should be on hand for removing wool from the pots. Measuring cups and spoons are a must, as is a small scale for weighing yarn. Keep some extra plastic dishpans available for use when rinsing and entering the wool. A few glass jars or plastic containers for storing leftover dyebaths may be desirable, too.

Some new dyers like to use a cooking thermometer, but it isn't absolutely necessary. You can tell if a bath is about to boil (at 200° F or so) when little bubbles appear around the edge of the pot. When the wool is in the pot always watch it carefully and reduce the heat to prevent boiling which may damage the yarn.

Reserve a place out of direct sunlight where the skeins can be laid on paper towels to dry. Keep pencils and cardboard tags ready for labeling the skeins as soon as they have been rinsed. Labels should include the name of the plant, mordants used, number of dyebaths, date and any other factors which might have contributed to the specific color which

NATURAL DYEING IN THE CLASSROOM Supplies used in classroom dyeing: electric burner, enamel pots, asbestos pad, yarn, scale, sieve, plastic basin, rubber gloves cotton string, buttons, labels, pencil, measuring cup and spoons, various mordants, wooden spoon, pot holder, thermometer, scissors and dried marigold blossoms.

Dissolving ferrous sulfate (iron) in hot water before adding to dyebath. This insures its even distribution in dyebath.

Dried marigold blossoms are being heated in dyebath solution. Fresh or dried, they give golds or pale greens.

Here marigold flowers are being strained from dyebath solution after boiling. Use marigold leaves for darker greens.

To prevent messiness in a classroom situation, the plant parts used for dyeing can be tied in a piece of old sheeting.

Here skeins of wool are being washed in a mild soapy solution before dyeing. Usually several washes are necessary.

Skeins being lifted from pot to show effect of different mordants. Mordants (chemicals) control final dye colors.

A demonstration of how to wind a skein of yarn around the elbow and hand. The skeins are then tied (see opposite page) and, after washing, inserted in the dyebath.

Skeins are lifted from pot or dyebath after being treated with different mordants and yield different color shades as a result. The yarn at left was treated with alum; the center, chrome; the right, no mordant.

A skein laid out to dry after being dyed. It has been labeled with such information as type of plant and mordants used and date. Note how skein has been tied with cotton string in "figure 8" knots to keep yarn untangled in dyebath.

resulted. It is very easy to confuse samples as soon as the dyeing is completed unless each skein is identified immediately. Keeping careful records on these tags is also helpful in planning and comparing future experiments.

Classroom Technique

Write on the blackboard the recipes you plan to use so everyone in the group can see them. However, if students are to work individually, keep a card with the recipe for each pot at the place where the work is being done.

Depending on the age and number of members in the class, let them do as much of the work as possible. With young children, demonstrate the entire process first, then at the next meeting ask for some help. Since electric burners and hot dyebaths are used, it is wise to have another adult as an assistant. Finally, don't allow too many students to work on the same dyepot or too much confusion and excitement may arise.

Children's interest will be greatest if familiar plant materials are used. The best materials are those which they can collect and bring to class. Below are a few easy recipes that may be applied to a number of materials with modifications possible through the use of various mordants. Information and instruction on mordants will be found on pages 4 and 5 and in Botanic Garden Handbook No. 46, pages 9-13.

Recipe 1

Plant materials to try with Recipe 1: onion skins (red or yellow); flowers of marigold, goldenrod, dahlia, coreopsis, gloriosa daisy (*Rudbeckia* cv.), snapdragon, zinnia, sunflower (*Helianthus*), or cosmos; horse-tails (*Equisetum*); tomato vines; coffee and tea.

Place the dye plant material in a pan with enough water to cover it. Bring to boil and boil vigorously for 30 minutes. Strain out material or remove bag containing it and add enough water to make a solution, allowing one quart for each ounce of yarn to be dyed. (If you wish to combine additive mordants, tbis is the time to do so. Be sure to dissolve the additive in hot water first and then stir it into the solution before the wool is added.)

Wet the skeins which have been

Gathering gloriosa daisy, a cultivated form of blackeyed-Susan, which results in yellows and shades of green.

prepared for dyeing and gradually change the temperature of the water around them until it is the same as that of the dyebath. Squeeze the excess water out of the skeins and then poke them down into the dyebath solution until they are completely covered. *Simmer,* do not boil, for about ½ hour.

Remove the skeins from the dyepot and place them in a container of water which has been heated to the temperature of the dyebath. Rinse well by using increasingly cooler water until the skeins are cool. Be sure there is no more color coming from the wool. Squeeze dry and place on paper towels to dry thoroughly. Label immediately. (If there is still a good amount of dye in the bath it is possible to incorporate other additive mordants and more yarn to produce a broader range of colors or shades.)

Recipe 2

Plant materials to try with Recipe 2: leaves of rhododendron, lily-of-the-valley (*Convallaria*), bayberry (*Myrica*) or privet (*Ligustrum*); sumac fruits; black walnut hulls; sassafras roots; logwood chips; oak bark.

Chop up leaves or pulverize roots and barks and soak overnight in enough water to cover them. Bring to a boil and boil vigorously for 45 minutes. Strain out dyestuff or remove bag and add enough water to make a solution, allowing one quart for each ounce of yarn to be dyed. Proceed as in Recipe 1.

Upon Completion

Clean up after each dyeing experiment. Usually a dyebath is "exhausted" (has no more useful color in it) when the last skein of wool dyed is a very pale shade. There is no reason to save these solutions. However, if no more time is available and a solution still seems quite strong, it can be stored for a short while in a covered container in a cool place. Fermentation of the bath for a period of a month or so may give you a different color you like or may only result in a washed-out shade.

At the end of a workshop for adults it is good to give participants a small sample of all the colors obtained. In advance prepare a sheet listing the plant materials to be used and the basic mordants to be tried with each. Punch a hole in the paper opposite each of these so that at the end it will be easy to tie in a piece of yarn from each sample.

For a children's class it is more appropriate to do a final project together such as making a chart to be hung for reference and display. Use the skeins of dyed yarn and plant materials which yielded each color. Someone might use part of the yarns to make a woven or needlepoint sampler. Be sure to keep the yarns labeled.

Finally, test the yarn samples for fastness. Expose one half of each sample to direct sunlight for a month or so and then compare the two halves to see which colors have faded and which are fast. (See centerfold.) This also could be included in the classroom display.

Enthusiasm will very likely be generated through a child's or adult's first experience with natural dyeing. The basic method of dyeing is not complicated, and a variety of plant materials may be used. Have fun. Go forth and "dye." ♦

PREPARATION OF SHEEP FLEECE FOR DYEING

Edna Blackburn

ONE of the pleasures of natural plant dyeing is that it leads to a better understanding of various allied crafts that were well known to our ancestors but which have largely passed away from the everyday household scene. As a result of the current revival in home dyeing, which has caught the interest of many younger people, hobbyists striving for authenticity often want to prepare many of their own materials. It is possible to do this with wool, particularly in a rural area.

Sources of Wool and Breeds of Sheep

Many countries have wool pools or cooperatives. Your provincial or State Department of Agriculture may be able to help you to find the one in your area.* The fleeces are shorn in the early spring and shipped to a receiving place. It will make it easier if the purchaser has a project in mind and is choosing a fleece for that purpose. For example, a long, staple, coarse fleece, derived from the Lincoln, Cotswold or Leicester breeds of sheep, is selected for rugs. A medium fleece, from Hampshire, Shropshire and Cheviot breeds, is used for sweaters, socks, mittens and blankets. Down breeds, which include Southdown, Dorset and Oxford, or fine woolled sheep (Merino), are employed for fine garments.

Another way to obtain a good fleece is to find a sheep breeder, know the breed of sheep he raises and purchase directly from him. Often in this way you will be able to look at the fleece on the sheep. It should be healthy with lanolin and not webbed. It should also have good tensile strength and a good crimp. If the sheep has been sick or undernourished the fleece could be rotten on the sheep's back.

If possible, the purchaser should know the count system of choosing a fleece, as a double check. The count refers to the number of hanks that can be spun from a pound of a particular kind of wool. The long woolled breeds are usually 30 to 38, medium 40 to 58, down breeds 56 to 60 and fine wools 60 to 120.

Buy the fleece clean. Most sheep men skirt the fleece before rolling and tying. It is rolled with the outside in and the part near the body outside. If buying a rolled fleece, pull a lock and test for general health. The fleece should be shorn in one piece.

Sorting

Take special care in sorting, handling and washing the fleece. First, sort the fleece by laying it on the floor with the exterior of the fleece up. Start sorting from the poorer parts and work up to the best parts. Begin by skirting off the gray and short pieces, then the britch, as it may be stained.

Next, skirt the prime part, which is over the tail. Wind and bad weather may have made it dry and coarse. Proceed to the diamond area in the middle of the back, bearing in mind that it may contain grain and hay dropped on the fleece when the sheep were indoors. This finally leaves the Extra Diamond, which is the best part of the fleece.

Washing and Drying

Soak the unwashed fleece overnight in water as hot as the hand can bear. The next day wash the fleece in small sections

*Sources of fleece are also sometimes given in specialized periodicals including *Shuttle, Spindle and Dyepot*, a quarterly publication of the Handweavers Guild of America, 1013 Farmington Avenue, West Hartford, Connecticut 06107; *Shepherd Magazine*, Sheffield, Mass. 01257, which gives lists of sheep breeders; *Handweaver & Craftsman*, a bimonthly with offices at 220 Fifth Avenue, New York, N.Y. 10001.

in a clean soap or detergent bath. Avoid an overly sudsy bath mixture because it dries out the fleece by removing much of the natural lanolin. Rinse gently—don't squeeze or wring. Lift the fleece out of the rinse water and let it drain. Handle it gently to avoid matting. If the fleece can be put outdoors to dry, it will fluff up.

Another method is to take groups of locks of the fleece and wash by swishing them in hot suds. The part of the lock closest to the body is known as the head and the outer part is called the tail. Hold the locks by the head and swish the tails in hot suds, thereby releasing the dirt. Then rinse the fleece, spread it out to dry or put directly in the mordant. It can then be dyed. Chicken wire, with large holes, attached to a frame is useful for spreading out the locks to dry in the outdoor air.

This treatment is especially good for down breeds as Southdown or the fine wool of the Merino. Southdown fleece is very short and has much crimp. Merino fleece, which has a fine crimp, is difficult to handle but worthwhile if washed and carded with care.

Color and Thickness

Even though the fleece is taken from one sheep, its color will not be uniform. For this reason it should be picked over before it is dyed to obtain a more even dye color. If the color of the fleece is still uneven after dyeing, it should be picked again, before beginning the processes of carding and spinning.

If the fleece is to be used for a specific project, decide the thickness of the yarn and how much is needed. The loss in going from the unprepared or "grease" fleece to the washed and dyed fleece is 40 or 50 per cent. Thus, if five pounds of prepared wool are needed, wash ten pounds of fleece.

If a mordant is required for the dyebath, alum plus cream of tartar is satisfactory because of its mildness. Other mordants may be used to obtain a good range of color even though they may have a tendency to make the wool brittle and tender.

The wool should still have elasticity after washing, mordanting and dyeing. The best utensils are brass, copper, stainless steel, pyrex and enamelware. Be sure of temperature (simmer, don't boil the wool) and of ample room for the fleece to float. Avoid crowding in the utensil as it will not permit even mordanting or dyeing. ♦

Madder Root

TO dye 2 oz. of wool, prepare 4 skeins of wool, each weighing ½ ounce. Premordant 2 skeins with alum and cream of tartar and 2 skeins with chrome.

Place ½ ounce of pulverized madder root *(Rubia tinctorum)* in 2 separate muslin bags and soak in 2 quarts of water overnight. The following day heat the madder and water gradually to the boiling point. Let it boil vigorously for only 10 minutes. Remove the madder from the dyebath and divide the dye evenly in 2 dyepots. (The madder root may be used for a second, weaker dyebath later.)

Place the 2 alum-premordanted skeins in 1 dyepot and the chrome-premordanted skeins in the other. Simmer the yarn in the pots for 30 minutes. Remove all the skeins from the dyebaths. Add a pinch of tin to the 1 bath and replace 1 of the alum-mordanted skeins in it. Add a pinch of iron to the other bath and replace 1 of the chrome skeins in it. Simmer each bath for an additional 10 minutes. Rinse all the skeins thoroughly.

The resultant colors: Alum—red; alum plus tin—red-orange; chrome—garnet; chrome plus iron—deep dark red.—*Palmy Weigle*

DYE PLANTS OF THE DEEP SOUTH

Willi and Fred Gerber

THE Deep South of the United States shares a large part of its flora with both the North and the Midwest; however, it has botanical elements distinct from these other areas. Counting the stands of naturalized indigo and the presence of useable wild type cochineal, the dyer can produce from its flora every color without exception.

Lichens

Lichens abound in most parts of the South. The majority respond to boiling water methods but there are also the orchil-producing types, well represented from sea level to over 6,000 feet in the Great Balsam Range of western North Carolina and in the Great Smoky Mountains extending along the North Carolina-Tennessee boundary. The identification of lichens seems fraught with apparently insurmountable difficulties for the uninitiated. For the average dyer nothing equals the keeping of color samples filed with a piece of the lichen responsible for the color and collection data.

A *Ramilina* which has been found in the specialized flora of Florida Indian shell mounds will produce a soft rose color when macerated and subjected to long steeping in a solution of one-third clear non-detergent ammonia and two-thirds water.

Many species of *Cladonia,* which grow in incredible quantities from the sandy pine barrens of the coastal regions to the sphagnum swamps of the mountain tops, will produce a range of soft colors from tans to medium browns by using boiling water methods. *Usnea,* or old man's beard, found in a wide range on trees, shrubs and fence posts, will give much the same colors as *Cladonia* but stronger, sometimes reaching clear golds and rich red-browns in the case of *C. strigosa*

Some *Parmelia* species give an exciting range of colors from medium browns to rich rust-reds and even red-violets. There are a few species of particular note. One soft gray leafy *Parmelia,* found in large colonies on the cedars along fresh water streams and brackish creeks along the coast and on the cabbage palms (*Sabal palmetto*), yields rich rust-reds and imparts a delightful permanent fragrance. Another ruffly edged species, somewhat similar to the above and often found in close conjunction with *Parmelia perforatum* on the twigs of the oaks, produces orchil colors with the ammonia method. *P. caperata* gives good strong even browns without reddish tones. *P. tinctoria,* which has been found on the Gulf Coast and is reported to extend northward into Kentucky, is an orchil of outstanding quality useful for deep magenta with ammonia methods.

Equally exciting are the *Umbilicaria* species of high altitudes. *U. pensylvanica* and *U. papulosa* are found in large quantities generally on rocks that are frequently wet by the mists of the high altitudes. Less often they may be found in the shade of mountain-laurel or rhododendron above 4,000 feet in our lower latitudes. (They grow at sea level in the North.) They produce a rich range of colors from lavender to magenta when used directly from the ammonia preparation or they may be shifted into rose, old rose, cherry-red and rust-reds by the addition of a mild acid to the dyebath.

.The orchil bath from *U. pensylvanica,* if used cold overnight for dyeing wool, gives beautiful intense magentas more brilliant than any others and clearer than if used with heat. Soaking dyed wool in water after rinsing will give a weak dyebath that with heat will dye a soft clear pure pink with no trace of lavender.

Lobaria pulmonaria, known as oak rag,

P. W. Grace

Familiar in the countryside of the North and South in fall and winter are the crimson berry clusters of the staghorn sumac (*Rhus typhina*). The berries yield a khaki dye. Both bark and leaves are rich in tannin.

is generally found on a variety of trees in the mountain areas. This lichen is already well documented for the intense rust-red brown that it will give with boiling water. *Lobaria* may be collected in fair quantity also at higher elevations.

Further south, in Florida, some of the gray crustose lichens on citrus trees will produce bright yellows equivalent to the yellows of *Evernia vulpina* of the West.

Indigo

In a class by itself are the stands of *Indigofera suffruticosa,* remnants in our flora from the Colonial Period when indigo was a commercial crop. It has become naturalized in several places. Where it can be protected from frost it may be treated as a perennial or, where winters are cold, it may be grown easily from seed as a cultivated dyeplant in greenhouses. Indigo blues, therefore, are readily produced here and additional colors are available from the fresh plant. Pinks, lavenders, tans and browns may be had from the dyebath with heat, because the plants contain pigments that are lost in the commercial preparations of the dried product.

The dye is extracted by steeping the twigs and leaves in water from 12 to 18 hours. Indigo is pH sensitive and may be shifted to bluer colors with small additions of some alkali.

Other Dye Plants

Elderberries (*Sambucus* spp.) are common throughout the South in wet places and along roadsides. The fruit will give soft blues and lavenders.

Yellows may be had virtually everywhere from the annuals, perennials, and the woody elements of plants from both field and garden. Noteworthy plants of the garden for yellows, some greens and less often orange, include marigold, dahlia, zinnia and the onion (skins). Goldenrods (*Solidago* spp.), wild carrot or Queen Anne's-lace (*Daucus carota*) and *Coreopsis* (both annual and perennial species) are all easily cultivated. Butterfly-weed (*Asclepias tuberosa*) and many of the St. John's-worts (*Hypericum* spp.) are used as garden subjects and are good dye plants. Milkweed (*Asclepias syriaca*) is often a serious pest, yet because of its dye qualities should be on every dyer's list.

Other outstanding dye plants for yellows are: *Flaveria linearis,* a composite

The foliage of *Rhododendron maximum* produces rich warm gray shades when cooked with copperas in an iron pot.

which occurs in the brackish soils along coastal waterways; *Bigelowia nudata* and *B. virgata,* resembling a small, semi-succulent goldenrod, found in moist meadows; and various jointweeds (*Polygonella*) of the buckwheat tribe, which give a clear bright soft yellow. The tips of the current year's growth with the leaves and green fruits of the black cherry (*Prunus serotina*) give an incredible range of not only yellows but also oranges. This tree is frequently encountered along fence rows north and south. *Cassia fasciculata* and *C. aspera* both give brilliant intense yellows and produce a dyebath of unusual strength that can be used more than once for strong colors. Both will also yield "cutch" browns and khaki. Hypericums are already famous for their dye qualities and the South has many woody and herbaceous species. *Chrysopsis* species are excellent not only for yellows but also form a variety of browns and near black. In Florida they bloom most of the winter and provide a source of dye when most other flowering plants are past.

The goldenrods are also well known and seem best gathered just before flowering when the spikes show color. *Gnaphalium obtusifolium,* one of the pearly everlastings, a weed of roadsides and open fields, is also good. Beggar-ticks (*Bidens*), especially the adventive *B. tripartita* of wet ditches and swamps, are equivalent to *Coreopsis. Coreopsis,* as wild annuals or cultivated perennials, are all among the best. *Coreopsis major* is perhaps the most dramatic herbaceous dyeplant of the Southeast. It produces incredible red-orange colors with alum and ammonia, yellow-orange with alum alone, rust-red orange colors with alum and copper, and strong chocolate brown with alum, iron and ammonia. The noxious weed dog-fennel (*Eupatorium capillifolium*), common as far north as Philadelphia, seems unreported for its dye characteristics. It should be included in every dyer's lists.

The intensities of the yellows of the plants noted above vary over a wide range and may be further modified with additions of tin and tartar or intensified and cleared, if they seem somewhat muddy, by using ammonia in the dyebath for the last few minutes of dyeing or as an addition to the first rinse bath. Many of these same plants with chrome rather than alum produce good brass colors.

P. W. Grace

The fox or wild grape (*Vitis labrusca*) is a fast-spreading vine of waste places and countryside from New England to Georgia. Its berries yield a purple dye.

Many of them with copper or iron sulfate produce greens of a variety of qualities. These greens with ammonia either intensify or shift to tans and browns. In the case of goldenrod the shift can be to excellent blacks.

Various species of *Balduina*, annuals of the southern coastal plain and the Gulf States, occur in large colonies in the poor soils of the pine barrens. They are excellent not only for yellows and brass colors but for icy cool greens if alum and copper sulfate are used.

The grass genus *Andropogon,* in all its many species, ranks among the best and is one of the recognized yellows for bottoming* with indigo for greens. With alum and copper it produces its own greens without indigo overdyeing. *Andropogon* occurs throughout the East either in single-stemmed plants or in large easily collected clumps, according to species. The genus is found along roadsides, in waste places and poor soils. It is superb for drying for winter use.

Many of the above plants are also important for orange colors. Special note is made in this respect to the entire group of *Bidens,* to the related genus *Coreopsis,* and to *Prunus.* Some of the colors are intense enough to vie with madder (*Rubia tinctorum*) for honors and many even produce the garnet colors associated with madder. Bedstraws (*Galium*), which are close relatives of madder, are common but the roots are small and the ability to produce the same colors as madder seems more academic than useful.

American mistletoe (*Phoradendron*), mordanted with alum, emerges from the dyebath pallid and poor until rinsed with ammonia water, when it changes to brilliant yellow. If stored overnight, wet, it often changes to a lovely chartreuse.

The green hulls of black walnut and butternut trees are well known for their intense browns. Hickory hulls can be used for unusual grays of remarkable clarity. Second-growth American chestnuts often produce burrs that have high tinctorial power and also give a variety of browns depending upon the mordants used.

Fetterbush or dog hobble (*Leucothoe fontanesiana*; formerly *L. catesbaei*), especially in late winter, gives unusual and

*Bottoming involves dyeing a second color over a first for a blend. It is a standard method for obtaining greens.

The seaside goldenrod (*Solidago sempervirens*) is native over a wide area north and south. Its flowers, among the brightest and latest of goldenrods to appear in the fall, yield a lemon-colored dye if an alum mordant is used. With potassium dichromate as a mordant, the color ranges from old gold to tan.

P. W. Grace

Philip B. Mullan

Fresh-cut goldenrod flowers ready for the dyebath. Although the flowers can be used fresh or in the dried state, the brightest dyes result when the flowers are picked just as they begin to open. When the flowers are dried for later use, they open and go to seed, but good dye colors can still be obtained from these dried parts.

good browns as well as yellows and some greens. *Rhododendron* in the higher altitudes and *Magnolia grandiflora* of the coastal regions will produce good gray colors if the foliage is cooked with copperas in an iron pot.

The red stems of rhubarb, with oxalic acid and tin, give lavender as do the "flowers" (bracts) of the subtropic garden favorite, poinsettia. Pigweed (*Chenopodium album*), another noxious weed of waste places, roadsides and railway embankments, gives a superb moss green with alum and copper or iron. The fruits of all species of sumac (*Rhus*), cooked with copperas in an iron pot, also give outstanding gray colors. If sumac foliage is also cooked with the fruit in an iron pot with copperas, then good blacks result.

The juice of the ripe fruit of the prickly-pears (*Opuntia* spp.), when slightly fermented and used as a cold dyebath with alum or chrome-mordanted wool, produces unusual pinks and salmon colors of respectable lasting quality. These cacti are common in Florida and one of them, *O. compressa,* has a listed range as far north as Nantucket Island on the northeastern coast.

The high tannin of many of the oaks (*Quercus*) and hemlock (*Tsuga*) may be used with iron sulfate for a variety of grays and blacks. If other pigments are present, tans and browns of great permanence result. Black oak (*Quercus velutina*), known as the source of the dyestuff quercitron, has a range extending throughout the East and as far south as Georgia. Although the bark as a dyestuff is well documented, it is insufficiently known by today's dyers. It is a year-round source of yellows and yellow-orange colors. Southern bayberries (*Myrica* spp.) equal their northern counterparts; sassafras, native to both areas, is famous for its pinky tans.

Cochineal

The *Opuntia* cacti are frequently infested with conspicuous white mats of the scale-covered bodies of the females of the insect *Dactylopius coccus,* cochineal. When enough are gathered all the reds, purples and oranges known for cochineal (see also page 57) may be had. Small quantities yield good intensity dyebaths for limited amounts of wool. Even a weak bath may be used more than once because it is the character of the pigments to be entirely depleted from the bath, given enough time and mordant. The regular cochineal recipes apply.

The wide geographic range of the South with its touches of subtropic flora and a wealth of species offers the dyer an inexhaustible supply of plants from which dyes may be produced. A multitude of species remain to be sampled for their dye potential. ♦

Pokeweed

WASH 1 oz. wool in a good soapsuds, then rinse and simmer it for 1 hour in ½ gallon of water to which has been added ½ cup vinegar. Remove the wool but do not rinse. Now add 2 quarts of ripe berries from pokeweed (*Phytolacca americana*) to the vinegar water and add another ½ cup of vinegar. Boil about 30 minutes. Strain and add enough water to make ½ gallon. Add the wool and simmer ½-1 hour, depending on the shade desired. At no time allow the wool to boil. Keep the bath at the simmering stage and the wool constantly pressed down under the water. Hang the wool to dry. In the next day or two rinse the wool thoroughly until the water is clear. This dye is not fast to sunlight.—*Palmy Weigle*

BLUE GOES FOR DOWN

How indigo dye came to Liberia—a folk tale

Esther Warner Dendel

IN the long ago and far away when High God left the earth, he went to live in the sky. The sky was close to earth in those days, so close it rested on the hills and mountains and sagged into the valleys. Energetic women feared to beat their pestles too high lest they pierce the fabric of the sky just above their heads and poke the spirit of a departed elder. What calamity!

It was better, really better, that High God, after being whacked a few times by busy women, left the spirits of the departed elders and went higher and farther from people. At least the low-lying sky was left to blanket man and shield him from the fierce sun. The people in their loneliness for God made sacrifices to the spirits of the ancestors and gave them messages to carry to God.

The sky did more for man in those days than to shade him and to house the spirits. Bits of sky could be eaten. This was different from other foods. Rice and palm oil fill the belly. Sky fills the heart. With a scrap of cloud inside him, a person can float and dream and find again the peaceful, joyous feelings that filled him before High God left the earth.

It was dangerous business, this eating of cloud. One had to come to cloud-food pure in thought and body. Even so, one could become cloud-drunk, sweetly drunk and unknowing. This is what happened to Asi, the seeress of Foya Kamara.

On a bright morning Asi came to the banks of the stream that flows past the town. She came with her girl child tied on her back under a pure white *lappa* of country cloth. On Asi's head was a raffia bag filled with rice which she must cook and eat on the sacred spot where an altar to the river spirit stood against a great silk-cotton tree. In her hands she held a

Photographs by Esther Warner Dendel

Indigo leaves have been stripped from their stems in Liberia.

After the leaves have been collected, they are beaten into a paste. This is a scene in Liberia.

hollow stick. In its hollow was the winking red eye of a lump of charcoal for lighting the sacred fire.

Asi walked calmly, her head high and straight as she neared the altar because one does not rush with unseemly haste to a sacred place. She collected sticks from the forest and lighted the fire between three rocks which held the sacred clay pot which was always left in the forest. After she had spread her *lappa* on the earth and made a cushion of leaves under it to soften the place for her child, she walked without clothes to the bank of the stream where she would rinse the pot and take water for cooking.

On sunny days strips of cloud came to lie down in the river. One could look down into the deep pools and see the beautiful blue color of the sky lying there in the sacred wetness. Asi had eyes and heart that were hungry for color. To Asi, the blue of the pools was the most beautiful color in all the world. Asi looked back at the bank of the stream where her child was lying on the white *lappa*. The color of the white *lappa* seemed a dead and lifeless thing that had never known sun or cloud or sky.

"Perhaps," thought Asi, "if I eat enough sky, the blue will come to my skin from inside me. With luck, my hair will be thunder-blue."

Asi shivered then because she knew that a seeress must not beg anything for herself at the holy pools; one must ask only for the entire people of the village. She had done a selfish, wicked thing just when she should have been most pure in her heart. Fear shook her body as she carried water for the rice toward the fire. What was done was done, the wicked thought had taken hold of her, she must beg forgiveness of the water spirit and think now of her sacred task.

When the pot of water had been set above the fire, Asi sat with her back against the great silk-cotton tree, waiting for the water to boil. "I will eat some sky now to make my heart lie down and be still," Asi told herself. Reaching up, she broke off a strip of sky as long as a plantain leaf and began to feed her lonely heart.

With the first swallow of sky, beautiful thoughts filled Asi. She felt herself within the roots of the trees far below her in the river-wet soil. The roots nuzzled the earth to drink the holy wetness the way a baby nuzzles a mother's breast to find milk.

A typical indigo vat for dyeing as it exists in Kano, Nigeria.

Also in Kano, Nigeria, scene at a typical indigo dyepit.

Continued from page 24

Asi's own breasts ached with the nuzzling of the roots because her spirit was there inside the sacred roots.

When the roots had drunk their fill and were ready to sleep, Asi's spirit rose and entered the body of a *veda* bird dancing in the air before her. The *veda* is a blue so bright it is a hurting, a lovely hurting to the eyes. It dances in one spot in the air when it is ready to mate. It was from floundering in the sky where the blue rubbed off on its body that the *veda* became this trembling, beautiful blue. Once again, the woman Asi became jealous of possessing this color, blue. She shook herself to try to rid her longing for color. Perhaps if she asked for the blue for all the people, not just for herself. . . . Asi rose and added the rice to the water in the pot which had begun to boil. She was calmer now and not so afraid since she had decided to make a begging for blue to come down to all the people of Foya Kamara. She saw that her baby was asleep on the white *lappa.* Asi was free to eat just one more bit of sky while the rice cooked. She would then leave her begging for blue along with some rice on the altar and go home before the forest was dark.

When Asi awoke, her head throbbed and she knew she had been drunk with sky. The forest no longer smelled sweet. No birds sang. In her nostrils was the stench of burned rice; she had spoiled the sacrifice she had come to make. The sun was low in the sky. Fear ate at Asi when she turned her aching head to look to her child. The baby had rolled off the *lappa* and was lying face down on the earth. Something strange about the *lappa* caught Asi's eye; there was a blue patch of color in the center where the baby had wet. One small patch of deep blue in the dead expanse of white. Asi did not stop to finger the *lappa.* She rose to her feet as quickly as she could get her joints together and ran to her baby. When she turned the child over, no breath came from its mouth.

Asi's baby was dead. This was the punishment for bringing selfish thoughts to that holy place. In a frenzy of grief Asi ran to the fire, now dead ashes, and loosened her hair to receive the grime of the ashes as is the custom with women in mourning. Tears streamed down her face, streaking the ashes she had piled on her head. Asi clutched her child to her, then wrapped the lifeless body in the *lappa* which was her own skirt. Her body

Indigo

THIS recipe for indigo has been supplied by The Mannings, East Berlin, Pennsylvania. The ingredients are: ½ oz. indigo powder, 1 oz. sal soda (washing soda), 2 oz. sodium hydrosulfite, 1 qt. warm water.

Put indigo powder in a small enamel saucepan. Add a little warm water and stir to a paste. Put sal soda in a measured jar. Add 4 oz. cold water and stir until the sal soda is thoroughly dissolved.

Add 2½ oz. of the fluid sal soda to the indigo paste in the saucepan. Stir and then shake in 1 oz. of sodium hydrosulfite. Add 1 qt. of warm water and heat to 130° F stirring gently. The liquid should show yellow or yellowish green when held to the light. Let stand for 20 minutes and then the dye is ready to be used.

Shake 1 oz. of sodium hydrosulfite over the surface to render harmless any undissolved oxygen. Enter wet skeins of wool in the dyebath for a few seconds. They should be yellowish-green when lifted from the bath and will turn blue as they are exposed to the air. Let dry and then rinse. Repeated dippings will give deeper color.—*Palmy Weigle*

Balls of indigo are shown drying in the sun in Liberia.

Scene inside a sacred dye house, also in Liberia.

rocked forward and back as she wailed and wept.

Finally, Asi felt the life and the grief going out of her. She fainted there at the base of the silk-cotton tree. And while she was in faint, the water spirit spoke to her, telling her about the blue spot on the white *lappa*. It was indigo, the spirit told her, and came from the leaves she had plucked to cushion her child. In order for the blue to stay, there must be urine and salt and ashes with indigo. It was necessary for the baby's spirit to leave its body; otherwise, Asi would not have added the salt of her tears and the ashes of her grief; the blue Asi had desired above all else would not have stayed on the earth.

Before Asi awakened from this trance, the spirit cautioned her that now since the color blue had come down to earth to stay, it was a sacred duty to guard the indigo and that only women too old to bear children should handle the indigo pots. Asi was to carry her new knowledge back to Foya Kamara and instruct the old women there how to make the blue juice live happily in the cloth for all the people. Only after that would Asi conceive again and the spirit of her child, just dead, return to live in her hut.

When the people of Foya Kamara awoke the next morning, they saw that the sky no longer rested on the hills or sagged to the roofs of the houses. High God, after having let women have the secret of blue for their clothes, pulled the sky up higher where no one could reach up to break off a piece for food. People look on the blue of fine cloth and have less need of a near sky, even though in their hearts they will always remain lonely for God. ♦

A METHOD FOR STORING DYED YARN SAMPLES

Nellie Bergh keeps her naturally dyed yarn samples in this neat file. She has tied a small sample of colored yarn to individual sheets of cardboard which make an even stack. Attached to each sheet of cardboard is a detailed label of the yarn's dyeing history—dyestuffs and mordants used and date.

A PRACTICAL APPROACH TO THE USE OF LICHENS

Phyllis Yacopino

LICHENS contain acids which are easily extracted, creating a broad range of dye possibilities for the home dyer. All lichens have particlar chemical characteristics. Once the dyer has a general understanding of how to distinguish the various lichen species, he can follow a basic procedure to extract these acids which in turn can be used for dyeing animal fibers such as wool and silk. Most lichens found locally can be used for dye purposes.

Generally, lichens grow in a wide range of habitats. Heat, sunlight, soil acidity, land elevation, and moisture are all environmental factors which determine where different lichens will be found. Lichens exist under specific conditions from deserts to swamps, from the Arctic to the tropics, growing on soils, rocks and trees.

Lichens provide exciting dyestuffs. Instead of attempting to find the lichens that have already been established as good dye sources it will be more profitable and enjoyable to become acquainted with lichens that are locally accessible. Test these to discover what dyes are available to you.

Charactertistics

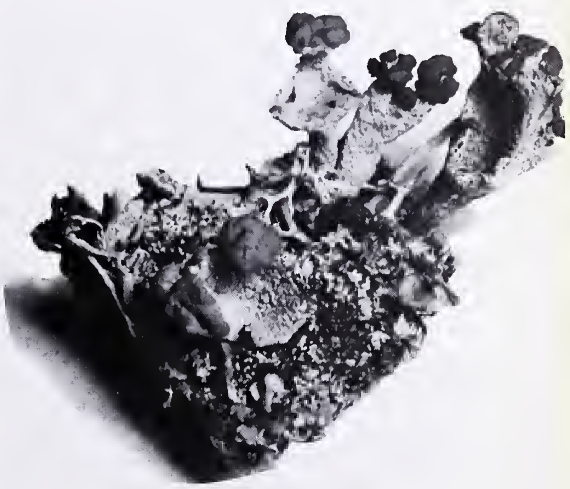
Lichens are made up of two organisms, a fungus and an alga, with the fungal strands entwined around the algal cells. The alga and fungus live symbiotically. By photosynthesis, food is manufactured by the alga and passed on, in part, to the fungus. The fungus, in turn, provides protection for the alga and may pass on nutrients needed by the alga. In color, lichens range from chartreuse to gray-green or olive to a dull gray or black. Some are a bright orange.

Many lichen features can be recognized with the naked eye, while there are other characteristics that can only be seen under a microscope. For the dyers' purposes we will rely on features that can be readily seen.

Collecting

Begin your lichen study with a field trip. Choose a rainy day or early morning since wet lichens are easier to gather. Take small paper bags for collecting. Avoid plastic bags as the lichens will mold in these, altering their dyeing potential. Bring a knife with a broad tip to scrape them from their growing surface. Carry everything in a large sack.

Go to a place where there are rocks and deciduous trees with low branches. (Lichens on pine trees are hardly ever very large because the bark flakes and much of the lichen is sloughed off.) Look at lichens growing on the ground, especially on banks and near trees. As you begin to notice the various lichens, start to distin-



The lichen genus *Cladonia* is diversified in form and widespread in distribution. Shown here is a cup-shaped species.

Two different kinds of reindeer-moss (*Cladonia*) which are true lichens rather than mosses.

guish them from each other and collect them separately.

Consider their growth forms, color and size, and these characteristics will distinguish various genera and species. Separate the types for possible identification at a later date. Dry and save them until enough are collected for dyeing. A small bagful is adequate for a good sample dye test.

Kinds

Three growth forms are most apparent among the lichens. *Crustose* ones appear as a fine crust or powder mainly on rocks or bark. Although they have dye possibilities, they are impractical to collect and will be excluded from our concern. The *foliose* types appear leaf-like. In contrast to these are the *fruticose* forms which may have an upright, stemlike growth habit.

With these distinctions in mind, concentrate on the different fruticose and foliose forms. Noticeable size variations may indicate different types. Turn the lichen over and examine the underside that was attached to the growing surface. Foliose undersides are quite different from their upper sides, while less difference is present in the fruticose types. Consider how the lichens were attached to the growing surface. Were they easy to peel or tightly attached? Were they attached by many connectors or a few? All are structural differences that may help separate lichens. Apothecia, the fruiting structures formed by the fungus, are cup-shaped projections on the upper surface containing the fungal spores. Some lichens may have soredia for propagation. These are aggregations of fungus and algal cells appearing as a powder on the surface or along the borders of the lichen plant body.

Extraction

Once the lichens are collected and dried, the next concern will be to extract their acids. Some acids are easily extracted by boiling as explained below. Since these acids are already present in the lichen, they are often visible by the color of the lichen. Many lichens with a yellow or yellow-green tint often contain usnic acid, and through the boiling method a rust-yellow color range may be derived. The genus *Usnea* itself, a fruticose type, is rich in usnic acid. Most fruticose lichens give good results when boiled. Other colored lichens may impart similar dyes. It is of interest that some mushrooms and other colored fungi can also yield dyes by this same method of extraction.

Other lichens contain colorless acids that need to be reacted upon with alkalis to produce a dye. Ammonia is often used and the lichens are soaked in a bath of it to obtain these dyes. These are historically called orchils. The same lichen may have both dyeing possibilities. (Always use fresh lichens for each test.)

The lichens producing orchils are not obvious by their natural color since the colored dye is actually created when ammonia is added to the acid. However, they may be determined by a simple chemical test. Using a single-edge razor, gently and carefully scrape the top layers of the lichen through the algal layer directly underneath until the white area, known as the medulla, is seen. A quarter-inch patch is sufficient. With a toothpick, place a small amount of household bleach on the medulla. If the white area turns orange, orchil-producing acids are present. The darker the color, the more acid is present. Sometimes certain acids need to be treated with a strong alkali before they will respond to the bleach. If no color is produced with the first test, soak the lichen in a strong alkali solution such as potassium or sodium hydroxide for a minute and then repeat the bleach test. If there are positive results, try the orchil dye recipe below. Many foliose types have orchils. As an example, *Umbilicaria* has large, leathery brown lobes—attached from one point to rocks—and is usually found near running water. The dye obtained here is a brilliant purple. Many other orchils yield blue-red colors.

Preparation

To prepare the lichen for dyeing, remove all debris, soil, moss and bark. Since the acids are inside the cells of the lichen, it is desirable to crush the lichen into a fine powder or to at least bruise or tear it for best results. Weigh the dried lichens to determine the quantity of wool to dye. For an experiment in colors, it is best to use one-half the weight of wool recommended in the recipe for the first bath and then make consecutive baths for lighter tones, until the dyebath is exhausted.

Use neutral pots and equipment such as stainless steel, enamel, ceramic, plastic or glass to avoid metal reactions that may alter the color.

To avoid confusion on the actual lichens used, number the different ones as well as the wool and dyebath. If precise identification seems important, an identical numbered specimen of the uncrushed lichen can be submitted to the biology departments of most state universities. Readers who wish to learn more about the identification of various kinds may also turn to Mason E. Hale's *How to Know the Lichens,* a soft cover edition of which was printed in 1969 by William C. Brown Co., Publishers, 135 S. Locust St., Dubuque, Iowa 52001.

Boiling Water Method—Method I

Use 1 pound wool to 1 pound lichen.

Fill dye pot with cold water and crushed lichen. Bring slowly to simmer. Simmer 2—3 hours. Leave overnight to cool. Enter wetted wool the next day. Simmer gently to depth of color (1—4 hours). Leave wool in bath until cold. Wash thoroughly.

Method 2—Contact Method

Use 1 pound wool to 1 pound lichen. Place layer of lichen on bottom of dye pot, layer of wool, etc., until pot is full. Fill pot with cold water (and acetic acid). Simmer gently until the desired shade is reached (1—4 hours). Leave in bath until it is cold. Wash.

Both methods yield good results. The Contact Method is more expedient and the same results are achieved.

Suggestions

Add 1 tsp. acetic acid per pound wool or 4 drops per ounce with the lichen to simmer 1—4 hours. Add premordanted wool with alum, chrome or tin. Leave wool in bath for 2—3 days. Take yarn out at different stages of simmering for a range of shades. Add caustic soda for change in color. For dyeing linen, premordant the yarn in alum for 2 hours and dye for 4 hours.

The worm lichen (*Thamnolia vermicularis*) is a stalked lichen, conspicuous for its very white color. It is found only above timberline in the White Mountains, Adirondacks and northern Rockies.

Orchil Extraction

Use 1 pound wool to 1/8—1/2 pound lichen. Cover powered lichen with 1—1½ parts household clear ammonia to 1 part water. Add enough solution to keep the lichen saturated and well covered by liquid. Cover container to avoid strong fumes from escaping. Add more solution as it evaporates, always keeping the lichen bathing. Keep the fermenting lichen in a warm place (60-75° F) as the fermentation will occur more quickly. Stir solution daily. Ferment 3—28 days.

Orchil Dyeing

Add fermented lichen and liquid to dyepot. Add enough water to make dye bath. Add wetted wool. The wool may dye by sitting in the dyebath for 3 days or by simmering until depth of shade is reached. The color is lighter without heating, but the brilliant purples are destroyed by simmering during the first dyebath. For the best results enter wool to a cold dyebath and raise to simmer as slowly as possible (1—3 hours). As soon as dyebath reaches 195° turn heat off and let the wool sit for 1—3 days in dye. Rinse thoroughly and continue to use the dyebath for lighter tones.

Suggestions

Dye can be used as soon as color runs strong, although the color will be darker and dye more wool the longer it ferments. Use fermented dye diluted by a water bath or let the solution evaporate. (Use 2 oz. wool to 1 tbs. powdered dye.) Add caustic soda for bluer shades. Add acetic acid for redder tones. Use premordanted wool, especially with tin to make dye more permanent in many cases. Wool may remain in the lichen dyebath for several days because the lichen acts as a softening agent and the dye can be more stable.

Dyes extracted by the boiling method are usually quite permanent. Orchils often fade when exposed to direct sunlight. Other than this extreme situation, orchils may remain brilliant indefinitely.

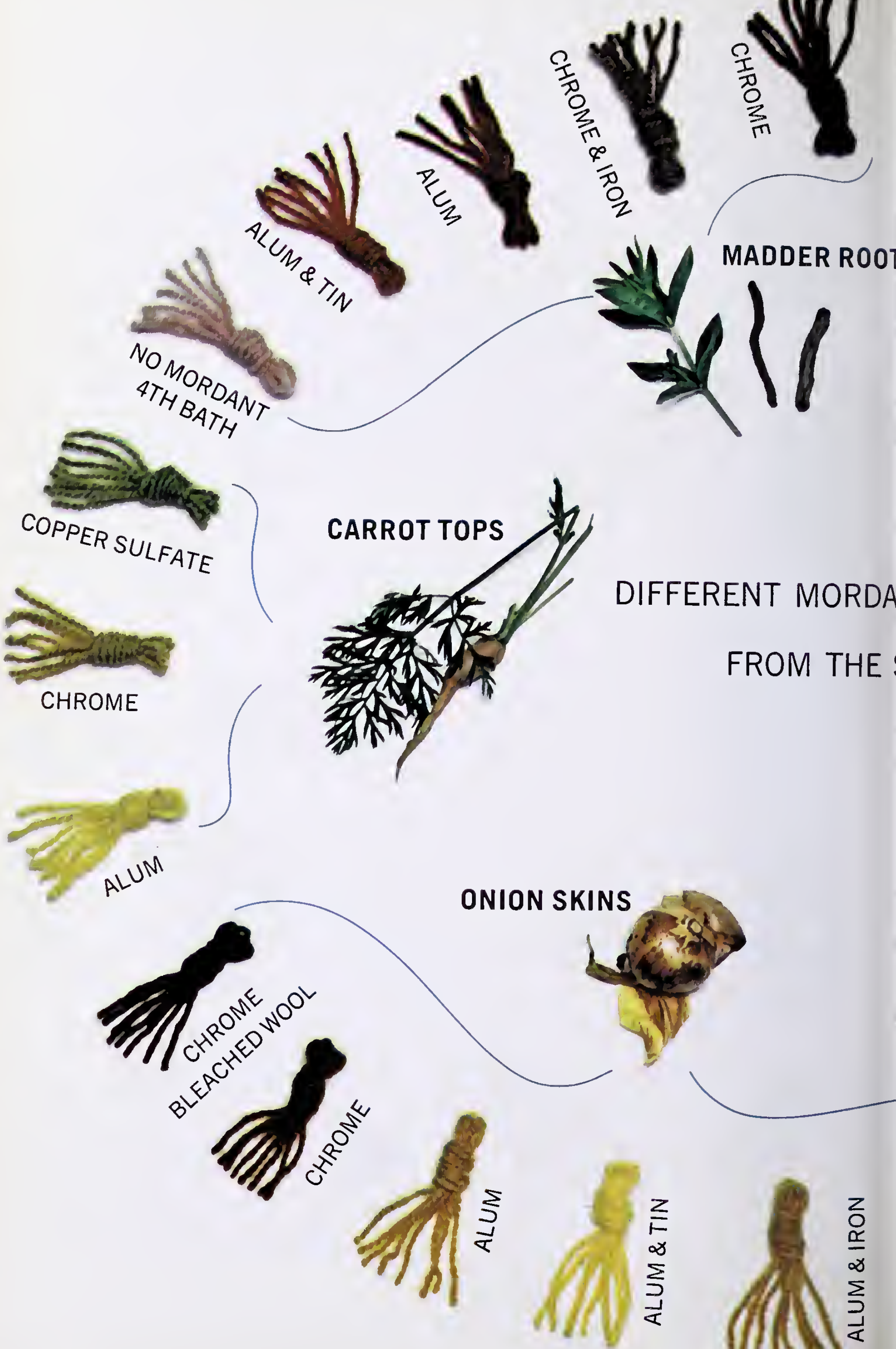
Lichens are abundant in many localities and are easily accessible dye sources, offering an extraordinary range of colors. Once the dyer becomes conscious of their presence and beauty, it should be stressed that lichens grow only milliliters per year. In fact, a good-sized community may take fifty years to develop. Always leave as many lichens as you collect from a given place so they may replenish themselves. Use them with discretion as a fellow conservationist. ♦

LICHENS FOR DYEING

1. AMMONIA, VINEGAR & TIN
2. AMMONIA
3. AMMONIA, VINEGAR & SAL SODA
4. VINEGAR, COPPER SULFATE & TIN
5. VINEGAR

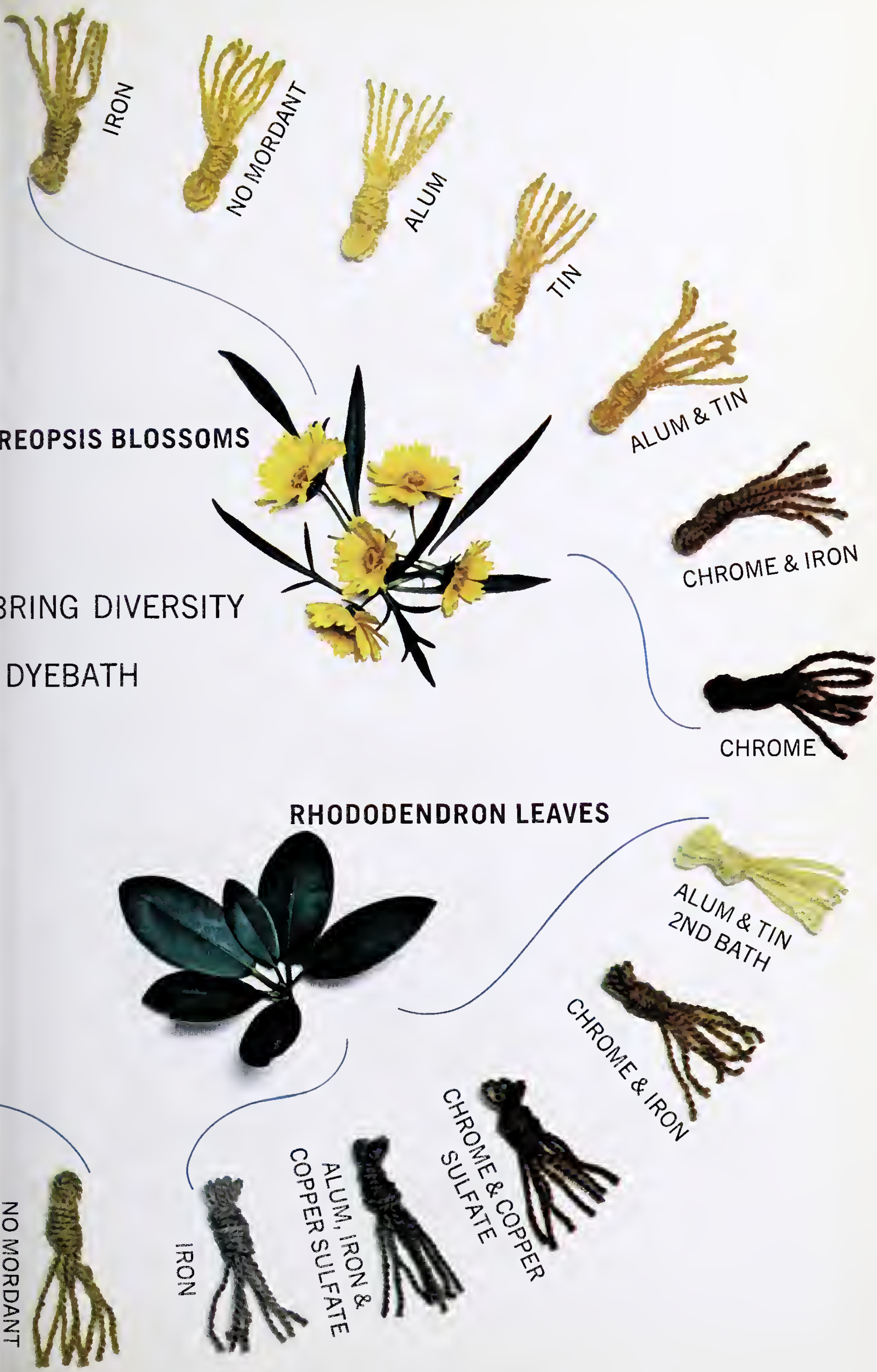
. CHROME & TIN
. AMMONIA & COPPER SULFATE
. AMMONIA, COPPER SULFATE, IRON & TIN
. COPPER SULFATE
. AMMONIA & COPPER SULFATE

11. TIN
12. AMMONIA
13. AMMONIA
14. AMMONIA & ALUM


MADDER ROOT
CHROME
CHROME & IRON
ALUM
ALUM & TIN
NO MORDANT
4TH BATH
CARROT TOPS
COPPER SULFATE
CHROME
ALUM
DIFFERENT MORDA
FROM THE
ONION SKINS
CHROME
BLEACHED WOOL
CHROME
ALUM
ALUM & TIN
ALUM & IRON

BRING DIVERSITY

E DYEBATH



A TEST FOR COLOR FASTNESS

HERE ARE SAMPLES which were dyed during a class given at the Brooklyn Botanic Garden. The classic dyes, logwood and madder, were used as well as some native and more commonly available materials. The left half of each sample was tightly covered with black plastic and taped down for five weeks, while the right side was exposed to direct sunlight for the same period. Then, the plastic was removed. You can easily see here which plants yield good fast colors and those that impart only a fugacious color to the wool. This sort of test is important if you are interested in using the wool you dye and are expecting it to hold its original color.

EVERNIA
Ammonia, Copper Sulfate & Tin

MARIGOLD BLOSSOMS
Alum

MARIGOLD BLOSSOMS
Chrome

MARIGOLD BLOSSOMS
Chrome & Tin

POKEBERRY BERRIES
Vinegar

RHODODENDRON LEAVES
Iron

MADDER ROOT
Alum

MADDER ROOT
Alum & Tin

MADDER ROOT
Chrome

MADDER ROOT
Chrome & Iron

LOGWOOD CHIPS
Tin

LOGWOOD CHIPS
Alum

LOGWOOD CHIPS
Chrome

ONION SKINS
Alum

ONION SKINS
Alum & Iron

ONION SKINS
Alum & Tin

ONION SKINS
Chrome

SOPHORA BLOSSOMS
Chrome

SOPHORA BLOSSOMS
Alum & Iron

COREOPSIS FOR REDS ON COTTON AND WOOL

Esther K. Hasel

A COMMON wild plant, a species of *Coreopsis,* grows on wet clay soil in the West, the Canadian prairies, other parts of the United States and Mexico where it was first used as a dye. (*C. tinctoria* is best known to dyers but other species of *Coreopsis* can also be used.) Coreopsis blooms all summer. Its flowers can be dried and kept for years in paper bags. After a hot summer, the resultant dye is stronger and more purple.

To dye cotton red: Soak dry flowers for one hour in fresh water. Heat bath quickly until the water feels hot. Then add just enough potash or washing soda to change the color from yellow to red. Pour off the dye into a separate container. Heat flowers again in fresh water adding a little more alkali to dissolve all of the dye. Add this dye into other dyebath.

The dye produces the best color when a few days old. Wash cotton goods in detergent before dyeing. Cotton material is dyed in cold solution. Leave overnight in bath, then rinse in water to which a bit of washing soda has been added if the water is not naturally alkaline, and dry the cotton in the sun. When first used, the dye may be orange-red and later purple-red. A little vinegar makes the dye more permanent. More potash should be added to develop the purple in later dyes.

To dye wool: The wool is mordanted first, using alum for orange-red and copper-sulfate for dark-red. Heat the coreopsis flowers in fresh water several times, each time pouring off the dye into a second container, and cool. Add the dry wool to the cold dye. Warm the bath and keep very warm until the wool is dyed orange or rust. Potash is added to make the water red. The wool is kept in this bath only until the red develops, then is rinsed in alkaline water and allowed to dry in the sun. Colors are bright and strong. Keep in mind that too much alkali may harm the wool. ♦

Eva Melady

THE SLEEPY HOLLOW RESTORATIONS SHAWLS

An adventure in matching colors

Sylvia Thorne

AT 17th century Philipsburg, Upper Mills, in North Tarrytown, New York and at Van Cortlandt Manor in nearby Croton-on-Hudson, authenticity is the name of the game. When Sleepy Hollow Restorations wanted a dozen shawls to complement costumes worn by hostesses at these historic landmarks, handspun yarns had to be dyed with natural dyes.

Sample cards of colors possible in Colonial times were contributed by members of the Handweavers Guild of Westchester, whose interest in plant dyeing had originally been stimulated by the Brooklyn Botanic Garden's workshops. Matching the selected shades was the challenge, and the following procedures relate to this task. With few exceptions the recipes used are given in B.B.G. Handbook No. 46.

For mordanting and dyeing the 3 pounds of wool needed for each shawl, an 11-gallon enamel clam-steamer pot was employed. The first sample attempted had been dyed with wilted lilacs. After mordanting with alum and cream of tartar, the yarn was simmered for about two hours with as many lilac blossoms as the dyepot would accommodate.

To test for a match, the sample was wetted. Then a few strands of the newly dyed yarn were squeezed between paper towels and both examined together in good daylight. After all dyestuff had been abstracted the resulting yellow still lacked substance. The addition of a very small amount of powered saffron produced a good match. The lilac odor even clung to the wool while it was woven.

Marigolds with an alum mordant produced an entirely different yellow. Flowers held in a freezer from the previous summer were boiled until the liquor became a dark bronze and then strained out before the wool was immersed. When the desired depth of color developed the yarn was allowed to become cool in the dyebath.

The cost of duplicating a sample originally dyed with saffron proved prohibitive. A substitute was found in the recipe given on page 21 of Brooklyn Handbook No. 46 for dyeing with smartweed (*Polygonum hydropiper*). A bushel of this abundant plant was first dried and used in conjunction with an ounce of powdered saffron.

The only problem in matching a very dark brown by using dried sumac berries mordanted with copper sulfate was that the 11-gallon vessel sprung a leak and dyed the floor too!

Another brown required butternuts at a time of year when none could be obtained. A successful substitute was achieved by boiling madder root until it lost its characteristic rosy hue and turned brown. This time fleece was "dyed-in-the-wool." When dry, however, the shade was too dark. An almost perfect match was finally accomplished by incorporating three light yellows dyed with onion skins and goldenrod. Exact proportions were evenly distributed and blended with a hand-carding machine (two cylinders that rotate against each other and are covered with wire teeth embedded in leather) for a completely even hue.

The indigo shawls presented the most difficulty. A Norwegian recipe called Olium was used. Olium is made by dissolving

Van Cortlandt Manor

The hostess, left, at Van Cortlandt Manor, a Colonial restoration, wears one of the shawls of handspun yarn, which for authenticity, had to be dyed with plant dyes.

powdered indigo in smoking sulfuric acid. A professional chemist procured the acid and made the basic dye solution at a laboratory. Instructions for dyeing with Olium can be found in Edward Worst's *Foot-power Loom Weaving,* available from Penland School of Crafts, Penland, North Carolina 28765. Briefly they are:

In a glass jar with a tight-fitting top gradually dissolve 15 grams (about 1 tablespoonful) of powdered indigo in 125 grams (a generous water cup) of smoking sulfuric acid. Stir the mixture with a glass rod. Close the jar tightly and allow to stand 24 hours or until needed.

When using Olium, pour a very small quantity—about 15 drops for a medium bright blue—into a glass measuring cup of cold water before adding to the dyebath. (Never add water to the Olium as it may effervesce dangerously.) Slowly add the mixture to a dyebath of *tepid* water and immerse the wool at once. If the water is hot the wool will be streaked and clouded. Stir quickly and keep it in motion until the boiling point. The amount of Olium determines the shade. After many experiments with indigo, urine is still the simplest solvent to use, and to quote Norman Kennedy, the Scot who produced splendid blues at Colonial Williamsburg, "It's the cheapest."

The leaky clam-steamer had to be replaced by a baby bath, also made of enamel. It held only 4½ gallons, which meant that for three shawls three separate batches had to be dyed-in-the-wool, none of them being exactly alike. Another problem arose because the fleece selected had come from sheep grazed on an island off the Maine coast, which is well known for its salt spray and fog. The indigo refused to penetrate all fibers equally and left a few patches of white. After carding the fleece, the color was slightly muted. But it was still an attractive unmistakable indigo.

The belated acquisition of a large copper clothes boiler made it possible to piece-dye the rest of the shawls after they had been woven.

Two shawls were dyed with cochineal, an important natural dye for hundreds of years and still in commercial use in the 20th century. Though not a plant, cochineal is derived from insects dependent upon species of cacti, particularly *Opuntia coccinellifera,* which is cultivated in Mexico and Peru for this purpose. (See page 57.) A rich rose was obtained with a mordant of tin and oxalic acid. One interesting result of using warp and weft yarns from two different animals was two dissimilar, but harmonizing shades, proving that no two fleeces will dye the same and should always be blended for complete uniformity.

Obviously, exact color matches from different dye lots are never quite attainable. But with determination and a little ingenuity it is possible to come satisfyingly close. ♦

The Rowan-Tree

THE European mountain-ash *(Sorbus aucuparia),* known in many parts of the world as rowan-tree, is one of the native trees of Sweden. American gardeners grow it primarily for its conspicuous orange-to-red fruits, which ripen in autumn and are often eaten by birds. Astrid Swenson reports that the fruits can be used as a dyestuff. With alum and cream of tartar as a mordant, and cooled in potash water, a greenish-yellow dye results. If chrome is used as a mordant and there is no cooling in potash water, the color will be light grayish-brown. Chrome, with iron and alum added to the dyebath for the last 15 minutes, produces a dark grayish brown. Also, a decoction of the ripe fruits is an excellent base for getting a very bright red with both madder and cochineal.

A SUBSTITUTE FOR A TRADITIONAL DYESTUFF

Miriam B. Hewitt

NOW that cudbear,* a traditional dyestuff, is difficult to obtain in the United States, it is helpful to know that a substitute is available within the boundaries of our own country. Certain orchil-producing lichens, when dried following maceration, yield a dye that appears to be similar to cudbear in all its coloring properties.

The dry orchil dyestuff used in our study was prepared from the lichens *Umbilicaria proboscidea* and *U. mammulata* (*pensylvanica*). They were collected at high elevations near Livengood in interior Alaska, where they intermix on rocks fully exposed to the long hours of summer sunshine. Both lichens may also be found in the boreal regions of the Northeast and the Northwest within the continental United States.

It appears that orchils prepared from *U. papulosa* and *U. mammulata,* both of which are more easily identified and more widely distributed in the eastern U.S., dye with no more than subtle differences. However the *U. mammulata* orchil is less potent than the others. If it is used, the quantity given in the following recipes should be doubled.

Preparation

In preparing the *Umbilicaria* dye substance, the lichen was rubbed through a a kitchen strainer to break the lichen into very small particles at the premaceration stage so it would be closer in form to the familiar cudbear powder when dried four weeks later in the final step. A kitchen blender will grind dry lichens into particles at least as fine as those produced by rubbing them through a strainer. One need only rinse the blender with a small portion of the ammonia-water solution to recover the dust, adding this first to the maceration.

When the lichen had been pulverized it was transferred to a jar, wetted with a little water, and then saturated to a stirrable consistency with a solution of one part non-detergent ammonia and two parts water. The jar was kept lidded in a warm spot except to stir the contents several times a day until the color ran. Stirring occurred less often thereafter. At the end of four weeks the macerated lichen was transferred to a glass bowl and dried at a uniform rate by mixing when necessary as the liquid evaporated. When thoroughly dry the orchil dyestuff had the appearance of very dark coffee grounds. It was considerably more granular than cudbear powder.

This dry orchil dyestuff, used in its granular form and without the addition of any other compound, produces a purple-red color similar to cudbear in value and intensity. Both dyes can be modified to the same colors by changing the pH of the dyebath through the addition of acetic acid or ammonia, and both dyes seem to be equally fugitive. In conducting the preceding investigation, one tablespoon of the dyestuff (one tablespoon of the dry orchil weighed 5.5 grams) was used in one gallon of water to dye 4 ounces of wool a color of medium value. In each case the dyestuff was soaked in a cup of hot water before it was added to the dyebath, and the wool was simmered for one hour and then cooled in the dyebath.

In extending the comparison between

*Cudbear is a prepared combination of the lichens *Ochrolechia tartarea* (a later substitute was *Umbilicaria pustulata*), *Urceolaria calcarea* and *Cladonia pyxidata.* It was patented in 1758 by a Scottish merchant, Cuthbert Gordon, who named it for his mother. See Rita J. Adrosko, *Natural Dyes in the United States,* p. 44.

Phyllis Yacopino

Umbilicaria and other lichens are macerated before they are used as dyes.

cudbear and the dried native orchil, traditional combination dyebaths were prepared of madder, cochineal and logwood. One bath of each of the above contained cudbear; a second contained an equal amount of the native orchil instead of cudbear. Following the same procedure, the dyed specimens were so alike in hue and intensity that only minor differences in value enable one to conclude the specimens did not come out of the same dyepot.

Recipes

The recipes given here are for one pound of wool premordanted with alum and cream of tartar.

madder root: 8 ounces
orchil: 1 ounce

Presoak the madder and orchil. Add them to the dyebath and stir well as it is brought to a temperature of 180° F. Hold the bath at 180° for 20 minutes before adding the premordanted wool, and then dye at the same temperature for one hour. Rinse thoroughly and then pass through a boiling soap bath. Color: deep red-orange. The orchil reddens the orange produced by madder alone.

cochineal: 2 ounces
common salt: 1 tablespoon
orchil: 1 tablespoon

Presoak the cochineal and orchil and dissolve the salt. Stir these into the dyebath, add the premordanted wool and bring the dyebath slowly to simmering. Simmer one hour and cool in the dyebath. Color: crimson. The orchil blues the red produced by cochineal alone.

logwood: 3 ounces
orchil: 1 ounce

Wrap the dyestuffs in cheesecloth and simmer in a small pot of water to extract as much color as possible. Add this liquid to the dyebath, stirring well. Add the premordanted wool and simmer for 30 minutes. Color: purple-red. For a navy blue, add 1/4 cup of ammonia to the bath at the end of the dyeing; for purple, brighten with tin.

Summary

It appears that one of the most practical uses of our native orchils could well be in these mixed dyebaths. The colors are rich and distinctive enough to warrant attention, and they do not seem to lose their initial color under normal fading conditions. Further study may show that orchils prepared from other indigenous umbilicate lichens behave the same way in these mixed dyebaths; and it would be interesting to explore the blooming properties of native orchils in other red and blue dyebaths. ♦

COLOR IN ICELAND

Astrid Swenson

HALLDÓRA Bjårnadóttir, the grande dame of Islandic crafts, has written a beautiful book on weaving in Icelandic homes. It is called *Vefnadur* (Menningarsjóds Publishers, Reykjavik, 1966).

Halldóra mentions that in Iceland all dyeing of yarn is done in the homes but that the natural colors of the wool are used very much for everyday wear. Many pictures in her book show how the whites, grays, browns and blacks give fine color variations to woven articles.

Since black wool is in great demand for clothing in Iceland but the supply of naturally black wool is far from sufficient, the Icelandic women carried on a long struggle until they found a way of dyeing a good black by using their own native material.

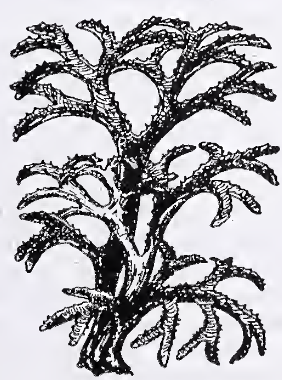
For many years something known as "the black plant" (*sorta*) was tried, but the color rubbed off. Black mud from the bogs (*sorti mutti*) and also bearberry (*Arctostaphylos uva-ursi*), which is called *sortulyng* in Icelandic, were used for some time. They yielded a black dye, but it was neither deep nor durable. Finally it was discovered that the combination of black mud and bearberry gave a beautiful and fast black color.

Indigo has been imported to Iceland since the early 19th century for more color-fast and clear blues than any native plant could yield. It is used with urine as a mordant in the old way, even though in most other western countries ammonia is now substituted for urine in similar dyeing processes. In Iceland the blue from indigo is called "stone-color."

However, with all these colors, natural as well as dyed, the very important red—"the queen's color"—was missing. Icelandic women had tried for centuries to find a native plant that would give a red color and, finally, also in the early 19th century their experiments led to a discovery.

First, the yarn was boiled with "*fjallagrös* (mountain-grass)—the lichen *Cetraria islandica.* Then it was treated for a couple of weeks with stale urine from pregnant cows (sometimes with a little of the national strong drink "black death" added to it). The result was what first was called the "cow-urine red," later named "Icelandic high-red." The color is bluish-red, "the true scarlet."

Final note: In Sweden *Cetraria islandica* is used with alum-mordanted yarn and an ordinary dyebath for yellowish-brown colors. ♦



G. G. Nearing

The Iceland-moss (*Cetraria islandica*), also called "mountain-grass" in Iceland, is widely distributed in northern countries, including the northern United States. It is a paper-thin lichen, brown to gray, olive-green when wet, and is found on both soil and rocks in tangled masses. Beyond its use in dyeing, according to G. G. Nearing in his *The Lichen Book,* this lichen has been important as food for humans and animals.

A DYEING PROJECT IN SWEDEN

Astrid Swenson

LAST summer during a visit to my native country, Sweden, I traveled back and forth through the countryside visiting relatives and friends, and at the same time conducted a kind of dye plant workshop for myself. At first I followed given recipes, then started to experiment with chemicals and with plants of my own choice.

Wild fruits such as blueberries, black currants and lingonberries are plentiful in Sweden. They proved to be a wonderful source of dyestuff even though I learned later such colors are not considered to be very fast. I also discovered that there are many interesting old (and even some new) methods of dyeing that should not be forgotten. Although they seem to be only locally known, the same ones may very well be found in other parts of the world with slight variations.

St. John's-wort

St. Johns-wort (*Hypericum*) has been the subject of religious as well as medicinal beliefs since heathen times. It has been used in brewing beer and aquavit, also as a source of red for coloring yarns. The color depends mainly on a tiny, intensely dark violet gland on the anther, which contains a reddish-violet fluid which dye fingers red if the buds and flowers are crushed with the hand.

There are about 300 species of *Hypericum* in the world, seven of them growing in Sweden. *H. maculatum* and *H. perforatum,* in that order, are the best for dyeing. (*H. perforatum* is now widely naturalized in the eastern U.S.). Although the roots and other parts of these plants may also be employed for dyeing, it is mostly the clusters of buds and flowers that are used, with a tin mordant, for red. Even late summer flowers, when dried, give a brownish red color to yarn mordanted with alum and cream of tartar.

The famous Swedish naturalist, Professor Anders Retzius (1742-1821), mentions in his *Flora Oeconomica* that the flowers of both *H. maculatum* and *H. perforatum,* when boiled with alum, give a "rather beautiful but not altogether fast red color." He added that they give yellow if alum and potash are used, while tin dissolved in aqua regia (1 part nitric acid to 3—4 parts hydrochloric acid) will result in "shades of rose, cherry and crimson red."

Yellow for Linen

Some of the finest linen in the world is to be found in and around Ångermanland, one of the northern provinces of Sweden. Soil and climate there seem to be perfect for flax (*Linum usitatissimum*), and as far back as is known, people on the farms grew flax for their own use. Many still do.

Because of the difficulties in dyeing linen, bleaching is the technique most frequently used. However, last summer when I visited my sister, Eva Varlenius, up north in Härnösand, she had rediscovered an old way of letting nature cure the flax yellow.

In the shade on the north side of the house, Eva put twenty "steps" (handy bundles of flax) side by side in a long row on the grass. In two or three weeks the combination of the moisture from the ground, the radiation from the sky, the dew during the nights and perhaps some rain was supposed to change the color from flaxen to warm yellow. She rolled the "steps" over a quarter of a turn each day and, sure enough, after ten days the flax started to have a certain glow, and it grew more golden each day.

Green for Linen

While I was visiting Härnösand, the local historical society arranged a crafts-

The European birch (*Betula pendula*, formerly *B. alba*) is a popular tree in many northern countries. Its leaves yield a creamy yellow when used with alum as a mordant.

P. W. Grace

man's day at the open-air museum, Murberget. Now I was to experience a second surprise concerning home-dyed linen. On a table in one of the old log cabins was a display of tablecloths, all woven in damask and made by women living in the area. All the cloths but one were woven in natural and/or bleached linen. The exception was woven with a natural warp and a soft green weft.

It was a rainy day but, in spite of the sparse light coming through the small windows, the interplay of light on all the tablecloths was magnificent, and the green one was particularly outstanding. Later in Gēdēa, I visited the woman, Anna Sporring, who had woven the tablecloth which, some years before, had earned her the silver medal at the National Country Fair. She was kind enough to tell me how she had produced the green color:

"I put well water into an untinned copper kettle on the stove. When the water was lukewarm I added soap flakes and some powdered sodium carbonate. When it all had dissolved I added my skeins of unwashed and unbleached linen, stirred often with a wooden spade and let it slowly come to a boil. After an hour of boiling and frequent stirring, I plunged the skeins directly from the hot bath into a zinc tub containing cold well water. The green color developed while the yarn was still in the cold water in the zinc tub."

Anna's story inspired me to do some vegetable dyeing, using either an untinned copper kettle, or an enamel pot with a layer of copper coins in the bottom, or by adding copper sulfate at the end of the dyeing, in each case using a zinc pail for the first rinse water. Sometimes no change was visible, sometimes the color turned lighter and sometimes the color changed into a darker shade. ◆

THE AUSTRALIAN EUCALYPTS

Jean K. Carman

EUCALYPTS or gum trees, as they are sometimes called (*Eucalyptus* spp.), are dominant features of the Australian landscape. Native to Australia, over 500 species of them are spread throughout the continent. A few also occur in the adjacent islands to the north and on Tasmania.

Eucalypts are adaptable to a very wide range of climatic conditions in Australia. They can be seen as giants in the southern rain forests, as stately trees along the banks of the inland rivers, as wind-twisted specimens of various shapes on the slopes of the Australian Alps, and as sparse, tough little trees of the arid areas.

Some species have been introduced to other countries. They are now flourishing in many parts of the world and are adding something of their own special beauty to alien landscapes.

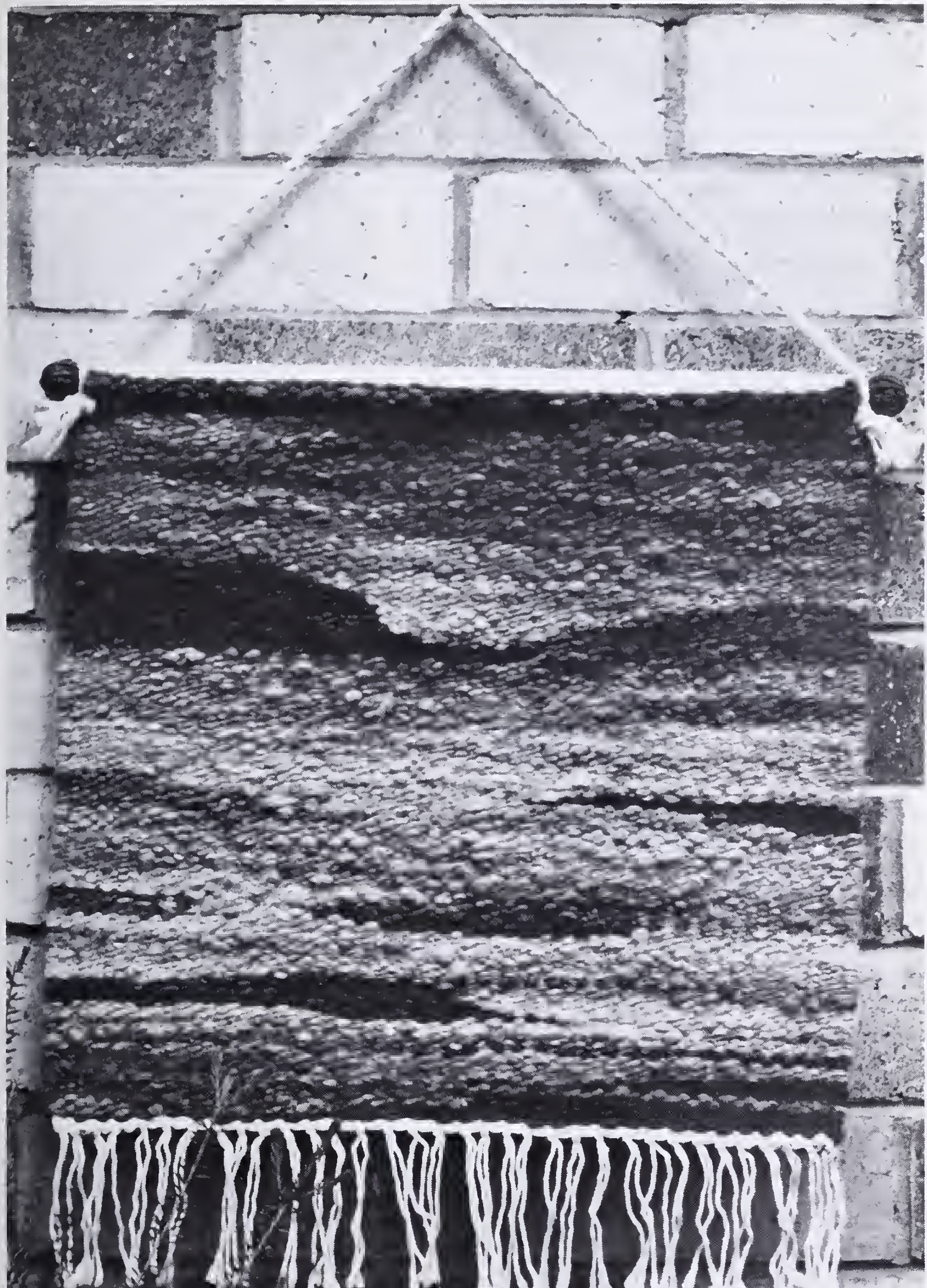
Five years ago, as a member of the Handweavers and Spinners Guild of Victoria, I overheard two acquaintances discussing the dye colors they had obtained from "gum" leaves. As the colors were quite different, I decided to test the leaves for dye color from the eleven species of eucalypts growing on our property. From these trees, with alum used as a mordant, such a range of colors was obtained that I decided to experiment further. With the help of family, friends, botanists and especially officers of the Forestry Departments, who collected leaves for me, over 130 species of eucalypts from each state of Australia, Papua and New Guinea have been tested.

To carry out these experiments, the four basic mordants—alum (potassium aluminum sulfate), tin (stannous chloride), copper (copper sulfate) and iron (ferrous sulfate)—were used. I also employed the standard method for mordanting the wool and adding the wool to the dyebath.

To prepare the dyebath, the leaves of the eucalypts were cut up and boiled in

C. Totterdell

Eucalyptus pauciflora, known in Australia as the snow gum, in Kosciusko State Park.



Jean K. Carman

The author created this tapestry from spindle-spun woollen yarn dyed from leaves of Australian eucalyptus trees. She calls the tapestry "The Sun-burnt Land." It demonstrates the wide range of dye colors possible from these trees.

Left: Eucalyptus cordata growing in the Canberra Botanic Gardens. Its leaves give a strong red dye, according to the author.

Photographs by Murray Fagg, courtesy Canberra Botanic Gardens

rain water in an enamel saucepan with the lid on, for one hour. A longer time is necessary if the leaves are thick, as in the case with some eucalypts from western Australia. Then, the liquid was strained and mordanted wool added.

Throughout the tests the same procedure was used and all weights and measurements were checked. The wool used was Border Leicester. (The finer wool, such as Merino, gives softer, paler shades.) The colors obtained did not fade after careful washing of the wool. Also, exposure to light did not affect them appreciably.

With alum as a mordant, dye colors ranged from red, orange and yellow to olive-green depending on the species of eucalypt used. Copper sulfate gave shades of green and brown, stannous chloride, yellow shades and ferrous sulfate, varying shades of gray.

It is interesting that a whole range of colors and shades can be obtained from one of the eucalypts, which gives a red dye (see below), by mixing the mordants. Also, black was obtained from two tallow-wood eucalypts, *E. microcorys* and *E. planchoniana,* by using a copper-sulfate mordant and adding ferrous sulfate to the dyebath.

In Victoria the most intense colors were obtained during the hot, dry summer months six years ago but, in less than 24 hours after the drought ended, the dye color from *E. cephalocarpa* (red) and *E. obliqua* (yellow) changed dramatically to much lighter shades. During the wet winter months that followed, the mountain-ash eucalyptus (*E. regnans*) and the snow gum (*E. pauciflora*) were a drab color instead of a clear yellow. I have since learned to obtain a consistent color by drying all leaves before dyeing.

Some species of eucalypts are found growing wild only in certain states of

The juvenile leaves of *Eucalyptus cordata*. This species is native to Tasmania.

Australia. Of those tested, the dye color remained the same, with the exception of the river red gum (*E. camaldulensis*). However, most of the eucalypts tested that have been grown out of their natural habitat produced different shades.

There are few species of eucalypts giving the red dye and these seem to come from the southern half of Australia. They include *E. cinerea, E. cephalocarpa, E. stuartiana, E. tetragona, E. cornuta* and *E. cordata.*

At present the strongest red dye I have obtained comes from *E. cordata,* which is native to Tasmania, and its dye color does not appear to change when the species is grown out of its natural habitat. Even wool mordanted with stannous chloride and copper sulfate will give red shades.

One last note on colors: It is possible to achieve varying shades of brown if the bark of eucalypts is employed. Regardless of shades, the dye colors from the eucalypts are very beautiful and they present a fitting complement to our "sunburnt" country. ♦

The Florist Eucalyptus

FOR northern dyers who do not have access to the many eucalypts of Australia, the silver-dollar eucalyptus (*Eucalyptus cinerea*), available at the florist shop, offers an interesting experience—and a heady fragrance.

Cut up several stalks of fresh eucalyptus and chop the leaves. Soak them overnight in water. The following day boil the stalks and leaves in the soaking water for about 45 minutes. Strain out the solid matter and use the dyebath with skeins that have been premordanted with alum or chrome. The colors will be yellow and gold. The addition of a pinch of tin to the dyebath heightens the intensity of the colors obtained.—*Palmy Weigle*

PLANT DYEING IN NEW ZEALAND

Joyce Lloyd and Molly Duncan

Photographs by George Bull

Clumps of New Zealand-flax (*Phormium tenax*), an important dye plant in New Zealand. All parts of the plant are used, including a sticky gum from the base of the plant. New Zealand-flax is an attractive ornamental that is featured in many mild-climate gardens.

PLANT dyeing will always remain a dominant feature in New Zealand wool crafts. Conditions for success are ideal. The climate of this agricultural country favors the growth of lush foliage—and the people are skilled plantsmen. Furthermore, wool is plentiful and, as most plant dyers know, it is the easiest of all fibers to dye.

Wools

The wools produced are mainly Romney and Crossbreds, which scour easily, this being of great advantage to the home craftsman as well as to the professional scourer. Short, fine Merino wools and long, staple Border Leicester and Lincoln wools are also available and are used for dyeing.

Extra care is necessary in the treatment of Merino wools to prevent matting and shrinkage. They cannot suffer much agitation in the dyebath, nor vigorous boiling, nor can they stand being plunged from cold water to hot water and vice versa. Lincoln wools have a natural lustrous appearance. This shows as a slight silky shine when the wool is dyed.

The home dyer in New Zealand has no preference for dyeing on loose wool rather than on spun yarn. Both are equally necessary and have their own advantages. On loose wool which, after dyeing, will be carded, blended and spun, level dyeing—*i.e.,* the insertion of such material as Glauber or other coarse salts in the bath to ensure even dyeing—is not extremely important. On yarn, it is. Spinning wool in the grease (without scouring) is the quickest method for a craftsman. For this reason dyeing in skeins is to his advantage.

Natural Dyes and Mordants

Chemical dyes as well as plant dyes are universally used. Any of the modern chemical dyes can now produce the soft color shades derived from plants (and be a "fast" color) but the joy of growing your own or collecting natural dyestuffs, exploring their secrets and transferring a part of them onto a natural fiber is a pleasure akin to all plant lovers.

The majority of natural dyestuffs require a mordant for more permanent colors. The mordants used in New Zealand are the basic ones—the metallic salts, alum, chrome, iron and tin. Others employed are: copper sulfate, for green colorings; acetic acid, for "opening up" the wool fiber to receive the dye evenly; cream of tartar, in combination with other chemicals; ammonia, to macerate lichens for orchil colors; sodium bicarbonate, with alum or sheet aluminum, for some deeper tones.

New Zealand-flax

Native plants growing in their natural soils generally yield strong colors. One of the best is New Zealand-flax (*Phormium tenax*). Dyes come from the flowers, stalks, seed pods, leaves and roots. The sticky gum that exudes from the base of the plant is particularly strong. This is the same plant that was invaluable to the Maoris for clothing, baskets, nets, rope and medicines. It is now grown by gardeners in mild climates around the world for its ornamental, long, strap-like leaves.

The following experiment for dyeing with New Zealand-flax may be of interest. After the long leaves have been cut for their fiber, the butt ends near the roots are very juicy. While they are still fresh, chop off strips and soak them in water immediately. After a few days a rich cinnamon brown liquid is ready for dyeing. Place the *Phormium* chips in a butter muslin bag and return to the dye liquid. Bring to a boil slowly. At a temperature around 120° F (50° C) enter skeins of wool pre-mordanted with each of the different mordants and warmed to the same temperature. Slowly bring to a boil (this should take about 20 minutes), simmer 20 minutes, and cool in dyebath 20 minutes. The skeins show all the colors listed below. Of course, if you mordant gray wool as well as white, the color range will be increased because the dye on the gray wool will be a deeper shade still. Here is the color range of New Zealand-flax when various parts of the plant and different mordants are used:

The leaves and branches of Kawa Kawa (*Macropiper excelsum*) yield a lime-green dye with chrome as a mordant. If copper is used, a bluish-green results. The tree is also called pepper-tree.

Flowers and buds
- Alum—pinky-fawn shades and tans
- Iron and copper—shades of brown
- Aluminum and soda—pinky-fawn
- Cream of tartar and tin—apricot shades

Leaves
- Alum plus iodized salt—pink
- Base of leaf with alum mordant—tan and apricot

Roots
- Alum—light brown
- Alum and soda—chocolate brown
- Bichromate of potash—good fawn shades
- Cream of tartar and tin—light golden brown

These result in good fast colors.

Use amount of dyestuff according to the color required—at least weight for weight with wool.

Flower stalks
- Alum—fawn shades

Other Dye Plants

Kawa Kawa (*Macropiper excelsum*), also known as native pepper tree. Leaves and branches are used. Colors: with chrome as a mordant, lime green; with copper, good bluish-green.

Kowhai (*Sophora microphylla*). The flowers, if used with alum, bring a primrose-yellow dye. Seed pods, also with alum, produce an orange-to-tan color.

Raurekau (*Coprosma australis*). *Coprosma* is a large genus in the coffee family (Rubiaceae). The ancient dye, madder, is another member of the family. Dye can probably be obtained from most, if not all coprosmas, but *C. australis* is by far the best and can be used without a mordant. It is a small tree, 12 to 20 feet tall. The bark is a dark brown and when cut reveals a bright orange. Use it for dyeing. If a mordant is required, use a little soda—tan shades to brown-chestnut. Other mordants and their results include:
- Alum—pinky-fawn
- Alum and soda—fawn to brown
- Copper—light to deep brown, according to dye strength
- Iron—deep brown
- Cream of tartar and tin—old gold
- Chrome—rich pinky-fawn
- Chrome, aluminum and soda—reddish-brown
- Aluminum and soda—tomato shade
- Aluminum, soda and a few grains of tin—red

Tanekaha (*Phyllocladus trichomanoides*), also known as celery-leaved-pine. The bark of this evergreen tree contains up to 28 per cent tannin and is a substantive dye. A lovely pinky-beige to cinnamon-brown color is obtained from the bark. A chrome mordant produces cinnamon-brown; aluminum and soda, a deeper brown.

Totara (*Podocarpus hallii*). The bark of this evergreen tree is thin and papery. The leaves are usually ¾—1 inch long, narrow and glossy. The bark is used in dyeing. A light brown color can be obtained if the mordant is alum and soda. An iron mordant brings sage green. ♦

A WORKSHOP ON NANTUCKET

Nantucket is well known for its plants considered ideal for dyeing

Mary Ann Beinecke

THE Nantucket School of Needlery, located on Nantucket Island, approximately 25 miles from the Massachusetts coast, is a nonprofit educational institution. Sponsored by the island's Historical Trust, it trains teachers for the resident school and the Extension Course for Home Study.

Needlery combines techniques of thread and fabrics for good design and art. Textile art requires the unique creation of each element for a specific result. Our interests are necessarily widespread and include learning many craft techniques as well as all aspects of design and color. The need for designed blends and styles led our school to spinning and hence to a study of fleeces, hairs, furs and wheels. This in turn led quite naturally to vegetable dyeing.

Our Historical Trust decided long ago to include vegetable dyeing among its restoration activities. The problem was finding knowledgeable consultants to instruct and develop a system for surveying the island and building a reference library of colors.

Our school is fortunate in having found Willi and Fred Gerber, from Florida, both Cornell-trained chemists and botanists. We sent the Gerbers a catalogue of the plants of our island, compiled by Frank McKeever and published by the Nantucket Historical Trust. They agreed to spend some time with us.

The Gerbers came to Nantucket several summers ago to prepare for an intensive three-week workshop. The first week they worked with the resident naturalist, Dave Carson, who led them to parts of the island where the plants noted in Dr. McKeever's list grew. Collecting and a few eager experiments began.

The Gerbers covered the walls with dried materials, dyed fleece and yarn samples. The building itself was ideal, well

P. W. Grace

Berries and foliage of bayberry (*Myrica pensylvanica*), a shrub prevalent in coastal areas. It tolerates sandy soil and salt-water spray. Its leaves yield a rich gray or gray-green or yellow dye.

equipped with natural light, plenty of work sinks, hot plates and outlets, dye laboratory, work tables and vented storage shelves. There was space outside for a drying line and garden.

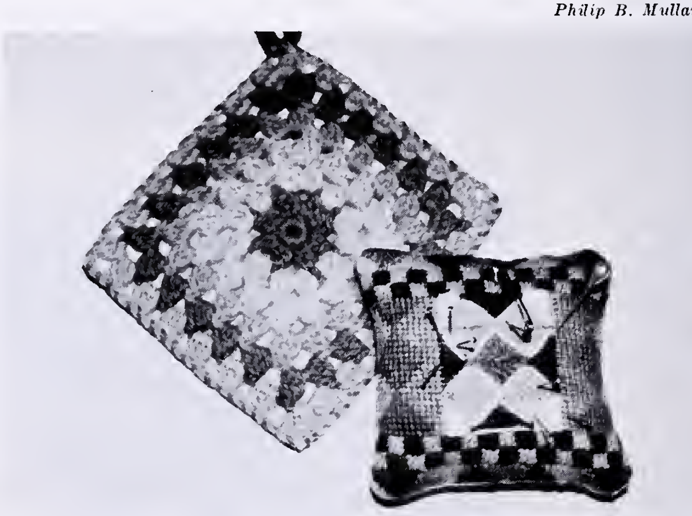
One week was scheduled for a study of local plants, another week for classical dye sources such as madder, cochineal and cutch, and the third week for orchils from lichen. The class was divided into five working partners. Each team generally had one plant assignment a day, each of these divided between a chrome series and an alum series. We used as a base the worsted yarn developed for needlery by our school as well as felted wool strips for hooking.

The next summer the Gerbers returned, this time for a week's spinning and two week's vegetable dyeing. The assignment following the previous workshop had been to develop an efficient universal cataloguing system to facilitate not only our filing but cross-referencing with others in the field.

The Gerbers had in the meantime added a post-mordant ammonia step so that a series now included several mordant combinations, for example: alum; alum-ammonia; tin and tartar; tin and tartar-ammonia; copper; copper-ammonia; copperas; copperas-ammonia. Besides a doubling of samples in each series, we added fleece to the yarn and felted wool bases. Two recipes were assigned to each team, making a total of 160 samples a day. The instructors did the collecting. In addition to the sheer weight of numbers, filing was complicated by the desire to catalog both an unspun and a spun sample. We also discovered that a very real part of the joy of vegetable dyeing lies in the collecting.

We have no doubt that the pooling of resources, files, energy and time, as well as the sharing of knowledge of experiments and exchange of ideas, will produce a revival of vegetable dyeing as a part of contemporary living. To that end, the Nantucket School of Needlery continues to implement the dyeing section of its rare book library and invites any interested scholar to "come study." ♦

Philip B. Mullan



Naturally dyed yarn can be used in many crafts. A pot holder has been crocheted with yarns dyed from blossoms of the tree *Sophora japonica*. The needlepoint pin holder (*right*) uses varying shades of maroon-pinks and purples derived from madder and brazilwood.

The skilled dyer combines a sensitivity for color with many of the skills of the chemist

THE CHEMISTRY OF DYEING

Beth Parrott

DYEING is a chemical process and dyes and fibers are chemicals. Dyers who have followed a recipe to arrive at a pleasing result often wish to understand something of the chemical skills and materials involved in the process.

Long before W. H. Perkin's discovery of synthetic mauve in 1856, dyers were attempting to understand and record the properties of the dyestuffs and auxiliary chemicals they used. In 1806, Elijah Bemiss wrote in *Dyer's Companion*:

> "The five Material Colours are these, Blue, Yellow, Red, Brown, and Black; the three powers are these, the Alkali, the Acid, and Corrosive; these are the depending powers of all colours; which I shall endeavor to show in each colour in course."

For Bemiss and his contemporaries, dyes and mordants were drugs. The druggist was interchangeably known as the chemist. Today, many of us still turn to the druggist or chemical company as a source for the materials we use. In turning to the chemist for information we can clearly benefit as well.

Fibers

In most natural dyeing, the chemistry of the fiber is as important as that of the dyestuffs. Two categories of fibers are used by most natural dyers. (A third type, synthetic, is beyond the scope of this Handbook.) These fibers are usually classified by their origin as animal or vegetable.

Fibers of animal origin, wool and silk, are made up primarily of protein. These fibers have many points, called active centers or sites, along them which are chemically active. They have the ability to act as both acids and alkalis (bases) and have considerable natural affinity for dyestuffs.

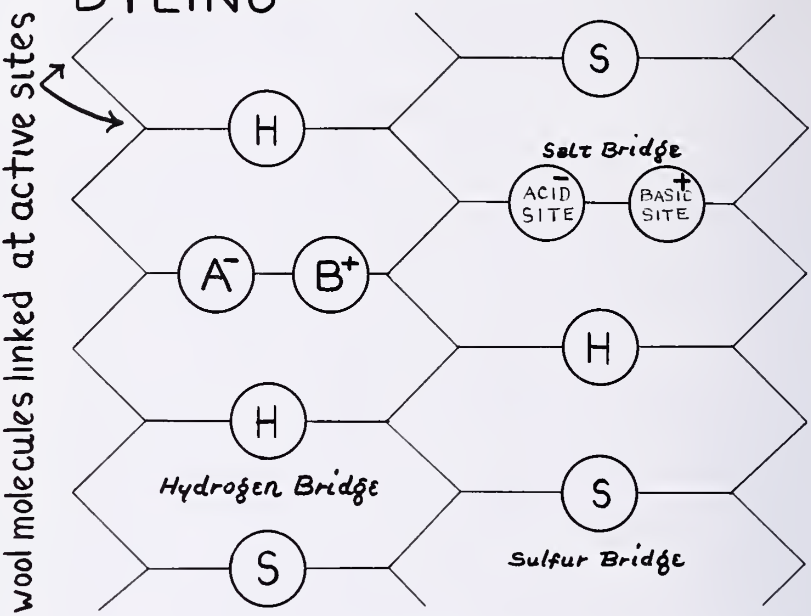
The wool fiber, which we will use as an example of this group, consists of many long protein molecules, lying side by side and joined by a variety of links or bridges. These bridges are also the major sites of dye attachment in the cases of chemically bonded dyes, as well as the sites of attack by chemicals which destroy the fibers. In order for their natural affinity for dyes to be utilized, the fibers must first be wetted. Water acts to weaken or interrup the links between adjacent molecules so the dyestuffs may be attracted to these chemically active sites.

At positions of acid or alkaline character, the neighboring protein molecules are oppositely charged (the acid site is negative, the alkaline site positive). Since opposite charges attract one another, a link between the molecules is formed called a *salt bridge*. Acid dyes which are negatively charged and basic (i.e. alkaline) dyes which are positively charged can substitute at these sites for the neighboring protein, forming salt bridges with the fiber.

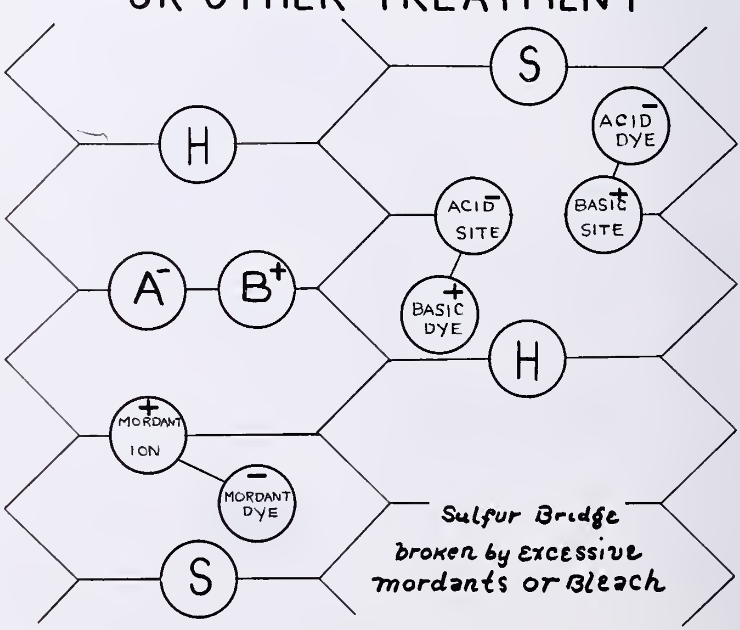
A second, weaker linkage between the neighboring protein molecules in the wool fiber occurs in parts of the molecule which are not able to act as acids or alkalis, but nevertheless are richer or poorer in electrons (negative). Areas occur which are slightly more negative or slightly more positive than the molecule as a whole. Links between the slightly positive areas of one molecule and the slightly negative areas of its neighbor are called *hydrogen bridges* (since hydrogen is almost always the slightly positive site). These hydrogen bridges are the site of attachment of the mordant-metals.

A third link between parts of the wool fiber occurs at positions where the chemical sulfur is part of the protein molecules. A strong, nearly permanent link de-

WOOL MOLECULES BEFORE DYEING



MOLECULAR CHANGES AFTER DYEING OR OTHER TREATMENT



velops between sulfur atoms on adjacent protein molecules, and these *sulfur bridges* form the backbone of the permanent structure of the wool fiber. These links are not involved in dyeing, but are destroyed by treatment with strong acids, alkalis and oxidizing agents such as bleaches. When these links are destroyed, the wool is essentially worthless, because the protein molecules are no longer linked together.

Vegetable fibers are predominantly cellulose, a complex carbohydrate in which nearly all of the chemically active or electrically attractive sites are already tightly bound up in the formation of the molecule itself. In some hydrogen bridge sites, the unlinked oxygen atoms are available and are probably the location of bonding for the direct cotton dyes. The mordanting of cotton and linen by the alum-tannic acid-alum method is really the breaking apart of the fiber in ways which allow additional chemical and electrical sites to be available to the mordant metals and/or the dyestuffs for interaction.

It may also include the permanent incorporation of parts of the tannic acid into the carbohydrate molecules, which make up the cellulose fibers, and then be followed by the bonding of the dyestuffs to salt bridges or hydrogen bridges in these bound tannic acid fragments as well as to those in the cellulose fiber itself.

Dyes

Natural dyes are water-soluble materials having the capacity to impart color to fiber. They play a variety of roles in the plant and animal sources from which they come, sometimes in their colored form, and sometimes in uncolored ones. When the dye is already present in its colored soluble form within the plant, as in the case of dahlia or marigold, processing the dye may be rapid and relatively simple. In other cases fermenation may be necessary to convert it to a soluble and/or colored form, requiring more complex and time-consuming methods. In the case of indigo, fermentation yields a soluble but colorless form. This solubility is necessary initially to remove the dyestuff from the plant material and, later, for the dyestuff to penetrate the fiber. In the case of logwood, a colorless, relatively insoluble form occurs in the fresh wood. During fermentation, a colored and more soluble form is produced which is readily removed from the wood and is ready for dyeing.

When dyes dissolve in water they may remain intact molecules, in which case they are neutral (have no electrical charge), or they may come apart chemically (dissociate) into smaller charged units called ions. The charges on these ions may be positive or negative, though the negative type is more common (See Acid Dyes below.) The form in which a dye occurs in water solution is of great importance, since it affects the way it works. For this reason dyes are classified as chemical or mechanical on the basis of how they work. In practice there will, however, be some overlapping.

(A) *Chemically Bonded Dyes,* in which a chemical relationship or reaction occurs between the dye and the fiber.

1. *Simple Dyes* (Substantive) which have a direct affinity for the fiber and are usually themselves colored. These are often fugitive but their fastness may be improved by aftertreatment with copper or iron. All natural dyes which chemically bond to wool without a mordant are in this group, but dyes such as the orchil lichens which are not affected by mordants are the best example. They can apparently act as either acid or basic dyes, with the color changing from pink in acid to blue in alkali. (See diagram.)

   a. *Acid Dyes,* which dye wool and silk directly in an acid or neutral bath. These dyes tend to be very easy to apply, and clear in shade, but have poor fastness to washing and limited fastness to light. The dye fragment in this case is a negatively charged ion. The berry dyes are all in this group, with the natural acids acting to promote the dyeing process. Additional acid, as vinegar, often aids the process, especially in low-acid berries, such as those of pokeberry.

P. W. Grace

Teasel (*Dipsacus sylvestris*) is a biennial weed whose seed heads are often sought for dried arrangements. Both flower heads and leaves will yield a yellow dye (with alum as a mordant).

Degree of dye uptake, evenness of dyeing, and fastness may be improved by the use of leveling agents such as common salt or Glauber's salts. Leveling agents derive their name from their capacity to aid even dyeing as well as evening the colors of fibers dyed in different lots. (See diagram.)

b. *Basic (Alkaline) Dyes,* which dye wool and silk from an alkaline bath and dye cotton after treatment with tannic acid. Color fastness is fair to poor, but ease of dyeing is an advantage. Ions of these dyes are positive. There are some dyes which dye wool without mordants or other auxiliaries; the so-called contact dyes are in this class. Hot-water lichen dyes are an example of this group. Soap residue from scouring, fermentation products, especially from urine or ammonia ferments, and 'mordants' which may not be acting as true mordants (all mordants produce an alkaline condition except chrome) may obscure natural basic dyes.

c. *Direct Dyes* which have a direct affinity for cotton. These dyes show poor fastness to wet treatment, good-light fastness, and ease of application. The best example of this group is turmeric yellow.

2. *Mordant Dyes* in which positively charged metal ions form a bridge between the fiber and the dye-stuff molecules. The metal ions usually used are aluminum, chromium, copper, iron or tin. While the fiber may in some cases be subjected to the mordant at the same time as the dye, or even afterwards, the usual procedure is to treat the fiber with the mordant in the form of a metal salt, forming a fiber-ion unit before dyeing. This process is followed by the introduction of dye which forms an insoluble complex salt (sometimes called a lake) with the metal within the fiber, yielding a fiber-ion-dye unit. (See diagram.)

Many dyes can act to some degree as acid or basic dyes but will dye with greater intensity and fastness if mordants are used. Other dyes will not respond to the fiber except in the presence of the

Marjorie J. Dietz

The pokeberry's dark red berries yield a dye. The berries are low in acid; the dyeing process is improved by the addition of vinegar.

metals. Dyes in the latter group are known for good to excellent light fastness, relatively good fastness to water treatment, and clear resultant colors. An additional advantage, that the colors obtained from a particular dyestuff may be varied rather widely according to the mordant used, more than makes up for the increased complexity of the dye process.

Among the oldest dyes to fall into this category is madder, which has traditionally been used with an alum mordant. One of the "mordant dyes" with the greatest range of reported colors is logwood, which, depending on the length of the fermentation to remove the dyestuff from the wood, the choice of mordants and the time of application of the mordants, can apparently produce reds, purples, blues, grays and blacks. Almost endless variation was obtained by combining with other dyestuffs. While I have not found reference in the dye literature to obtaining yellow from logwood, the chemical literature indicates that hematein, the coloring material from logwood, also takes on a yellow form.

While the effect of a particular mordant will vary greatly with the color and dyestuff with which it is used, the following generalizations seem to be true in most cases.

Aluminum—Produces brightest shades; least fast to light (not as bright as tin).

Iron—Saddens; produces dullest shades; good fastness to washing; relatively good fastness to light.

Copper—Produces greening effect; improves light fastness.

Chromium—Best fastness to washing; relatively good brightness; strengthens colors; good light fastness.

Tin—Brightens; good water and light fastness. (Should be used with extreme care because of effect on wool.)

(B) *Mechanically Bonded Dyes,* in which NO chemical relationship occurs between the dye and the fiber. All natural dyes in this group are *Precipitate Dyes,* including the *Vat Dyes,* which are pigments developed on or within the fiber. Insoluble pigments are treated to make them soluble, usually with alkali and/or a bacteriological ferment or chemical reducing agent. They are then adsorbed by the fibers and converted back to the insoluble form. While these dyes require the most complex and time-consuming procedures, they are the most durable dyestuffs known. Fastness to wet treatment and light, deep intense colors, and interchangeable use (in most cases, on both animal and vegetable fibers are among their advantages. They also include some of the oldest dyestuffs known. Prussian-blue and chrome-yellow are inorganic dyestuffs in this group. The plant world contributes woad and indigo, and many of the shellfish dyes, including the tyrian-purple of the Ancients, fall into this group. In fact, the chemical structure of the coloring material in indigo and tyrian-purple are nearly identical.

Repeated layers of dye deposits are necessary to produce deep colors. Because these are mechanically deposited dyes, and do not involve a chemical reaction with the fiber, the vat process is far less dependent on the nature of the fiber. However, since no chemical interaction exists between dye and fiber, vat dyes often rub off.

Factors Affecting Formation of the Dye-fiber Unit

Temperature. Increased temperature, particularly in the presence of water, tends to expand the fiber structure. This is important in providing greater surface area for the dyestuff to penetrate and on which to bind. Prolonged exposure to high temperatures, especially of animal fibers to temperatures above 180°F., tends to break down the strong structural bonds within the fiber, leading to pronounced deterioration of the material. Temperature may also have an effect on the dyestuff. An excellent example of this is the rapid deterioration of indigo at temperatures above 140°F.

pH. This is a chemical measure of acidity and alkalinity, neutral being 7 on a scale from 1-14. Numbers below 7 indicate acid conditions, with 1 being the strongest acid. Numbers above 7 indicate alkali, with 14 being the strongest base. Test papers which show a simple color indication of the pH of a solution are available from many druggists and most chemical supply houses. Also, a simple liquid pH test kit, available from pet stores for testing the water in aquariums, may be used.

The importance of pH cannot be stressed enough. The role of electrical charge in dye-fiber unit formation should be clear to the dyer. The pH is important in relation to these processes, because in acid solution there is an excess of positive and in alkaline solutions, an excess of negative charges. In the bonding of acid dyes to the fiber, acid is necessary to encourage bonding to occur. Similarly, alkaline conditions encourage the bonding of basic dyes. Later washing or rinsing of the dyed fiber in solutions of the wrong pH, as, for example, washing acid-dyed fibers in soap would cause the dye to "bleed" rapidly. For this reason a vinegar rinse is apt to be used for washing an acid-dyed fiber while a soap rinse may be indicative of an alkaline dye-stuff.

With mordants, however, strive to use neutral water, since the mordants themselves contribute alkali (except for chrome, which in the form of potassium or sodium dichromate is acid). Since the bonding of the mordant is at the slightly charged hydrogen bridges they may be sensitive to minor changes in pH.

As previously mentioned, the fibers themselves may be destroyed by strong acids or alkalis. The quality of the fiber will also be adversely affected by long exposures to milder acids and bases. Dyeing times in these solutions should be kept to the minimum necessary for adequate color.

Oxidation and Reduction. For our purposes these terms refer respectively to increasing or reducing the quantities of oxygen in the chemical structure of a substance. Oxidation and reduction are the key to the use of vat dyes. In the vat dyes, the oxidized form of the dyestuff is not soluble in water and therefore cannot

A Color Range from Cochineal

FOR *crimson red and scarlet colors* use four ½ oz. skeins 2 ply medium weight wool and ½ oz. powdered carmine cochineal. Preparation of bath: Tie cochineal in closely woven cloth bag and soak overnight in 2 qts. water. Next day boil vigorously for 15 minutes. Squeeze out as much dye as possible from the cochineal and remove the bag from the bath. Add enough water to bring the bath to 2 qts.

Dyeing the yarn: Place 2 unmordanted skeins and 2 alum-mordanted skeins in dyebath and simmer for 1½ hours. (The letters that follow in parentheses refer to the different colors obtained. See below.) Remove 1 unmordanted skein (a) and 1 alum-mordanted skein (b) from bath, rinse and dry. Divide the bath into 2 pots. Leave the second alum-mordanted skein in ½ of the bath to cool for several hours, then rinse and dry (c). To the other half of the bath add a pinch of tin and ¼ tsp. cream of tartar. Simmer in this bath the second unmordanted skein for 15 to 20 minutes more. Then add ¼ tsp. citric acid and simmer the skein for an additional 10-15 minutes. Rinse and dry (d).

Colors (according to the Royal Horticultural Society color chart):

a) Unmordanted—ruby red
b) Alum—chrysanthemum crimson
c) Alum cooled in bath—cardinal red
d) Unmordanted + tin + citric acid—currant red

For purple, lavender and rose colors, use four ½ oz. skeins 2 ply medium weight wool and ½ oz. powdered carmine cochineal. Preparation of bath: Follow the same procedure described above. Dyeing the yarn: Add 2 tsp. white vinegar to bath and simmer for 10 minutes. Place 2 unmordanted and 2 chrome-mordanted skeins of yarn in bath and simmer 1½ hours. Remove 1 unmordanted skein (e) and 1 chrome-mordanted skein (f); rinse and dry. Divide the bath into 2 pots. Allow the second chrome-mordanted skein to cool in ½ of the dyebath; rinse and dry (g). To the other half of the bath add a pinch of tin and ¼ tsp. cream of tartar. Simmer the remaining unmordanted skein for 15 minutes more; rinse and dry (h). Colors:

e) Unmordanted—fuchsia purple
f) Chrome—orchid purple
g) Chrome cooled in bath—erythrite red
h) Unmordanted + tin—Indian-lake red

—*Palmy Weigle*

reach the fiber. A biological or chemical reducing agent (e.g. fermentation or sodium hydrosulfite) is used to turn the dye into the colorless soluble form. After the dye has reached the fiber, oxygen in the air oxidizes the dyestuff to the colored but insoluble form which remains on the fiber.

Oxidation affects the sulfur bridges and eventually destroys them. While oxygen in the air is not strong enough to affect this change, the bleaches which are used on wool can destroy these links rapidly. Hydrogen peroxide and sodium hypochlorite, used as stripping agents to remove color from previously dyed fibers, as well as other stripping agents, are essentially bleaches and oxidizing agents; for this reason the quality of wool stripped of its dye for redyeing will always be poor.

Dyestuffs which are not strongly linked to the fibers may be susceptible to oxidation by the air. This often may result in changes of the colors, or even total loss of color. The changes that occur in berry colors with aging may be an example of this. Since light speeds up the process of oxidation in air, it may be helpful in the air oxidation of indigo, but may also be responsible for the sunfading of some colors, particularly those applied without the use of mordants.

Other Factors

Cleanliness of the fibers before dyeing is important. Foreign matter, particularly oils, naturally present in wool and often introduced in the spinning of other fibers, may interfere with the penetration of the dye. Cleansing agents used to scour the fibers should be rinsed out thoroughly, since they are often alkaline and may adversely affect the formation of the dye-fiber unit. Water softeners should be used with caution since they may introduce acid or alkali, or result in mineral precipitates which can cause uneven dyeing.

All chemical additives, including mordants, should be used in the minimum amounts necessary to accomplish the desired uptake of the dye. Excess mordants can attack the structural bonds of the fibers, causing deterioration or they may remain in the fiber, resulting in later unevenness of the dye. ♦

P. W. Grace

Philip B. Mullan

Zinnias, in many forms and colors, are among the most commonly cultivated annuals in most gardens. At left are the large-flowered double zinnias, at right, the variety known as 'Sombrero'. All zinnias yield warm gold to harvest dye colors.

Hoke Denetsosie, courtesy Bureau of Indian Affairs

WORDS TO A YOUNG WEAVER

We are the Dineh, my child
With the Earth we live
With the Sky we live
With the plants we live
We know their ways.

Heed well the plants, my child.
Learn the ways of each, my child.
Some you must ask for gently,
Pick their tips
Heat them softly
And they give.

Some of you must demand of strongly
Dig through the rock
Pound hard the roots
You will tire
And they will give.
Give to each as it requires
It will give to you, my child,
It will give to you.

We are the Dineh,
With the Earth we live
With the Sky we live
With the Plants we live
We know their ways.
Nature comes as it comes
Gives as it gives.
We do not plan Nature.
We do not control Nature.
It is so in dyeing the wool.

Receive your colors as they come.
Learn the ways of each.
Some plants dye strong enough alone.
Some take strength from other things.
The Ashes of the Juniper
The Minerals of the Soil
Give to the weak, strength, my child
And the colors that come are good.

The Red of the cliffs at sunset, will come.
The Yellow of the shimmering sand, will come.
The Green of the plant life around, will come.
The Black of the thunderclouds heavy will come.
All good colors will come, my child.
All good colors will come.

And do not try to match a color of the past.
This is a new day.
This is a new plant.
The colors that come forth are many,
None will be the same
And each that comes is good
And each that comes is good.

—Noël Bennett

* Navajo word for themselves meaning "the people."

SOUTHWEST NAVAJO DYES

Noël Bennett

NAVAJO dyeing reflects togetherness with nature. No chemical mordants are used *per se,* only those that occur naturally. These are added right to the dyebath, resulting in a process with appealing directness and simplicity.

Mordanting: Specific Instructions

1. *RAW ALUM* (tsé dík óózh). An alkaline crystal-like substance found in washes or other areas of recent water evaporation. Add ¼ cup directly to dyebath, boil 10 minutes and strain.
   Substitution with similar results:
   Aluminum potassium alum. Use 1 tsp. in dyebath.
2. *CEDAR ASHES* (ga dí lit). Ashes prepared from the juniper (*Juniperus monosperma*) which is called "cedar" by the Navajo.
   Preparation: Collect juniper branch tips about 1 ft. long. Build outdoor fire on windless day. Set fire to each branch and lay it on a grill with a container beneath to catch ashes. Dyeing ¼ lb. yarn usually requires ¼ cup ashes. Ashes may be stored for future use.
   Uses: Ash water: Juniper ashes may be added to twice the amount of boiling water, then stirred and strained. Mixture is then added to dyebath when the recipe calls for a mordant. No subsequent straining is necessary. *Ashes:* Juniper ashes may be added directly to the boiling dyebath at the time mordant is desired. The dyebath is stirred, boiled 10 minutes, and then strained. ¼ cup ashes = ½ cup ash water.
   Substitution with similar results:
   Ashes from burned logs or other hardwood.
3. *SALT:* Rock and regular salt are sometimes added directly to the dyebath, with no straining required.
4. *SODA AND BAKING POWDER:* These are much like raw alum and are also added directly to the dyebath. No straining is required. As with alum and ashes, water should not be near top as foaming frequently results in overflow.
5. *IRON AND ALUMINUM PANS:* These create duller shades. Rusty iron objects are also used.
6. *COAL.* If unavailable, use charcoal briquets.

Dyeing

Rabbitbrush, sagebrush, wild-carrot and mountain-mahogany recipes are given below. A variety of colors may be obtained and several dye methods and mordants tried.

RABBITBRUSH (*Chrysothamnus graveolens*) (G'iisoi—"that which is very yellow")
Color Range: Yellows, mustards.
General Description: Rabbitbrush is very easy to collect and one of the best plants to experiment with in terms of mordants and pans. It can be used year round, the yellow color being brightest during late summer bloom. This dye is extremely color-fast. The various species of this clumpy shrub grow from 1 to 5 feet tall. Rabbitbrush grows abundantly at all elevations, and bright yellow flowers cover the plant in late summer. It is especially common along highways where runoff increases moisture. Leaves are long, thin and of uniform width.
Part Used: Freshly snipped flowers for bright yellow; or other newly cut plant parts if yellow with greenish tinge is desired.
General Dyeing Procedure: Fill 3-gallon enamel pot with packed rabbitbrush clippings. Add water to ¾ mark. Boil one hour and remove plant material. Add one of the mordants below depending on color desired. Add ¼ lb. wet, hot yarn. Simmer ½ hour for lighter

tints, 1-3 hours for deeper shades. Rinse in water.

Rabbitbrush Mordants

Clear Yellow Color. No mordant required.

Bright Yellow. Add 1 tbs. commercial alum, boil 10 minutes and stir.

Yellow with Orange Tinge. One tbs. soda, stir, boil 10 minutes.

Yellow with Greenish Tinge. One tbs. baking powder, stir, boil 10 minutes; or ¼ cup raw alum, stir, boil 10 minutes. Strain.

Mustards and Ochres. An aluminum pan will dull colors into an ochre range.

SAGEBRUSH— (*Artemisia tridentata*) (Ts'ah)

Color Range: Yellows, greens.

General Description: Sagebrush is a very common shrub growing in the Southwest at elevations between 4,500-8,000 ft. From a distance the foliage has a blue-gray tinge. The leaves, small, thin and with three dents at the tip, have a sage odor when rubbed between the fingers.

Gathering Technique: Snip off twigs with leaves and use them fresh. Sagebrush may be prepared according to rabbitbrush recipe to produce shades of yellow.

For Yellow Green:

1) Fill 3-gallon aluminum pot with sagebrush clippings. (Don't use the flowers.) Add water to ¾ mark. Boil gently 10 minutes. Remove plant material. Add equivalent amount of fresh sagebrush clippings. Simmer 10 minutes. Remove plant material. *Result:* Greenish-yellow liquid that is clear.
2) Add following mordants to boiling dyebath to turn water a deep, opaque green: ¼ cup cedar ashes; 3 rusty items (iron); 3 charcoal briquets, or coal.
3) Simmer 10 minutes, stirring constantly. Remove all objects and strain well. Set aside for 2 days.
4) Add ¼ lb. wet, hot yarn. Simmer 10 minutes. Remove yarn. Add ⅛ cup salt. Stir well.
5) Reenter yarn. Simmer 10 minutes. Leave in dyepot overnight. Dry. (This gives a distinct yellow-green and may be used at this state if colorfastness to water is not important.)
6) Rinse in cold, still (not running) water for a slightly more yellowed green, or in two-week old urine for a gray-green.

WILD-CARROT (Canaigre, sorrel)*
(*Rumex hymenosepalus*) (Chaat'inii)

Color Range: Burnt red-orange, orange, ochre, dark brown

General Description: Wild-carrots are "ghost" plants. They appear in spring with fleshy, broad, dark green leaves, above which are a single-stemmed flower cluster. Almost overnight they are nowhere to be seen, a shriveled black shadow marking their spot—the foliage having withered and died. It is at this time they are gathered.

Wild-carrots are high in tannic acid and thus require no mordant for permanency and color fastness. The resulting dyes are unaffected by direct sun over the years. In addition, successive dyebaths yield continuing color.

Although not required for permanency, addition of soda to the dyebath will brighten and increase the orange color. These plants are particular in their growing locations, occurring most abundantly in sandy soil. Their root systems are extensive. It is best to inquire of local residents when seeking these plants, as sites on reservations are few and far between. It is recommended that you follow the normal conservation practices when gathering.

Part Used: Roots.

Collecting: Dig deeply with shovel around dried foliage to depths between 1-2 ft. Gather both new roots (bright

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* Not to be confused with Queen Anne's-lace (*Daucus carota*).

orange when broken) and old "rotten" ones (last year's crop). Each type results in a different color.

Storage Procedure: Roots can be used dried or fresh. *To dry:* Cut into pieces and lay them out in sun for several days. Turn them occasionally. When ready for use, dried pieces must first be soaked overnight.

Dyeing Procedures:

1) Cut roots into pieces. Add water in a 1 (roots) to 4 (water) ratio. Soak overnight if dried. Boil 1-2 hours and remove plant material. Strain.
2) Add mordant for colors described below. Add wet, hot yarn. Simmer 1 hour.
3) Rinse immediately or leave in pot overnight depending on depth of color desired.

Gold-orange

Aluminum or enamel pan. No mordant required. Young roots with orange interiors.

Burnt red-orange

Young roots with orange interiors. Use a metal pan. 1 tbs. baking soda. 1 tbs. salt.

Ochre-brown

Aluminum or iron pot. Old (rotten) carrots. No mordant.

Dark brown

Iron or aluminum pan. Old (rotten) carrots. 1 tbs. soda. 1 tbs. salt.

MOUNTAIN-MAHOGANY (*Cercocarpus montanus*) (Tse'esdaazii—"that which is heavy as stone")

Color Range: Burnt-orange, red-brown, purplish-brownish-rose

General Description: Nature has a way of protecting its treasures. Mountain-mahogany produces one of the most color-fast dyes in the lovely reddish hues that are hard to obtain naturally and locally.

This shrub tree grows in higher elevations of the Southwest (about 7,000 ft.). Found in very rocky soil, mountain-mahogany discourages all but very determined gatherers.

Serrated leaves are located in clusters directly upon the twig. The leaf is basically oval in shape (less than twice as long as it is wide) with prominent veins especially on the lighter underside. At some times of the year a long plume is present. Roots when scraped are a beautiful dark red.

Parts Used: Bark of the root.

Gathering Technique: Come well prepared for gathering—this plant seems to thrive in pitting its strength against human persistence. Dig for the roots with pick and shovel. Collect as much of the roots as you have energy for.

Additional Preparation: Haul roots home and begin pounding to release bark. Pound along root with heavy, flat rock or hammer on hard, smooth surface (cement). A large pile of roots yields a seemingly insignificant pile of bark. The bark must be soaked overnight in water.

General Dyeing Instructions:

1) Put ½ lb. root bark in 3-gallon enamel pot. Add water to ¾ mark. Boil 2 hours. Remove plant material. Replace evaporated water. Bring to boil again.
2) Add mordant for colors below. Add wet, hot yarn . . . ¼ lb. Simmer 1 hour. Leave in dyebath overnight. Remove yarn and rinse.

Pale reddish-brown (color of sandstone)
No mordant required.

Deep burnt-orange (like sandstone cliffs in the sunset)

Mordant: Add ¼ cup ashes or ½ cup ashwater. Strain if ashes are added directly, Add yarn. Simmer 1 hour. Remove yarn. Add ¼ cup salt. Stir until dissolved. Reenter yarn and simmer ½ hour. Leave the yarn in the bath overnight.

Purplish-brownish-reddish color

Use aluminum pot. Mordant: 1 tbs. soda. ¼ cup ashes or ½ cup ashwater. Stir. Boil 10 minutes. Strain if ashes are added directly. Reenter yarn. Simmer 20 minutes. Leave in dyebath overnight.

BOOKS FOR FURTHER READING

Elizabeth Alexander

THIS is not meant to be a complete list but does include some of the available books that deal generally with the subject of dyeing. There are many others that are concerned primarily with local plants and methods.

Natural Dyes in the U.S. by Rita J. Adrosko. Smithsonian Institution Press, Washington, D.C. 1968; also available in soft cover (Dover Books).

An extensive history of dyeing from 2000 B.C. comprises Part I. Part II has information on dye plant equipment, preparation of the dyebath, and scouring of wool and cotton. Discussion of mordanting, fastness and top dyeing. Recipes for 37 plants. Botanical names included. The book has several appendices: common names of chemicals; dyes occasionally mentioned in *Dyers Manuals* printed in America; excerpts from old *Dyers Manuals*.

Lichens for Vegetable Dyeing by Eileen Bolton. Studio Books, London, 1960. Reprinted by Robin & Russ Handweavers, McMinnville, Oregon. 1972.

In part, a history of lichens as dye plants. Preparation of dyebaths for lichens, including those using water extraction and those requiring ammonia extraction. Uses of dyes on wool, silk, feathers, leather and marble. Botanical names included. Color plates showing lichens in both the wet and dry state.

Navajo Native Dyes by Nonabah Bryan. U.S. Dept. of Interior, Haskell Institute, Kansas, 1940.

Preparation of wool and native preparation of mordants. Discussion of 33 local plants. Botanical, common and Indian names, as well as photographs of each plant.

Hopi Dyes by Mary-Russell Colton. Museum of Northern Arizona, Northland Press, Flagstaff, Arizona. 1965.

Pre-historic dyes in relation to the Indian of the American Southwest. Hopi methods of preparing wool, cotton and basket material, also mordants. The Hopi used 11 plants as dyestuffs. Botanical, common and Indian names.

Vegetable Dyeing by Alma Lesch. Watson-Guptill Publications, New York. 1970.

Extensive list of equipment used in home dyeing. Preparation of animal and vegetable fibers, including silk, wool, cotton, jute, sisal, linen, raffia and grasses. Dyebath preparations. Explanation of mordanting, mordants, leveling and fastness. Of the 151 recipes, 40 are concerned with widely distributed plants. Traditional dyestuffs also discussed.

Dyes from Plants of Australia and New Zealand by Joyce Lloyd. A. H. & A. W. Reed, Ltd., Wellington, N.Z. 1971.

Eight ancient dyes are mentioned in a chapter on the history of dyeing. Detailed explanation of equipment needed and preparation of wool and mordants. Separate chapters on various dye plant groups. Well illustrated, with common and most botanical names. Included are 119 dye plants. Although this book is devoted to a specific region, many of the plants are available in other lands.

The Use of Vegetable Dyes by Violetta Thurston, Dryad Press, Leicester, England. 1967.

Detailed discussions on collecting plants, preparing dyebaths, mordanting and scouring of wool. The importance of particular dyes in England. Most botanical as well as common names. The book includes 37 locally available plants, 7 lichens used throughout Great Britain and 13 traditional dyes. ♦

DYE PLANT SUPPLIES

Darrell Bailey, 15 Dutton Street, Bankstown, New South Wales 2200, Australia. (Dye material and fleece)

Bartlett Mills, Harmony, Maine 04942. (Woolen yarn)

Briggs & Littles Woolen Mill Ltd., Harvey Station, New Brunswick, Canada. (Natural woolen yarn)

Wm. Condon & Sons, Ltd., 65 Queen Street, Charlottetown, P.O. Box 129, Prince Edward Island, Canada. (Natural woolen yarn)

Cooper Kenworthy Inc., P.O. Box 6032, Providence, Rhode Island 02904. (Woolen yarn)

Dharma Trading Co., P.O. Box 1288, Berkeley, California 94701. (Dyes and yarns)

Kem Chemical Co., 545 S. Fulton St., Mount Vernon, New York 10550. (Bulk chemicals)

The Mannings, R.D. 2, East Berlin, Pennsylvania 17316. (Yarns)

Northwest Handcraft House, Ltd., 110 West Esplanade, North Vancouver, British Columbia, Canada. (Dyes, mordants, yarns)

The Sheldons, 82 Plants Dam Road, East Lyme, Connecticut 06333, (Dyes and yarns)

Straw Into Gold, 5550 College Avenue, Oakland, California 94618. (Yarns, dyes and seeds of unusual dye plants)

World Wide Herbs Ltd., 11 St. Catherine Street East, Montreal, Canada 129. (Dyes and mordants)

The above list was compiled from references of various dyers. For more complete information, send $1.00 for Suppliers Directory published by The Handweavers Guild of America, 1013 Farmington Avenue, West Hartford, Connecticut 06107.

—*Palmy Weigle*

P. W. Grace

The wood horsetail (*Equisetum sylvaticum*) in early spring. The stalks will yield a warm gray with alum mordant.

Marsh-marigold (*Caltha palustris*) has yellow flowers in early spring that yield a yellow dye with alum mordant.

INDEX OF NATURAL DYE SOURCES

(Numbers in boldface indicate illustrations)

BROOKLYN BOTANIC GARDEN RECORD
PLANTS & GARDENS

BROAD-LEAVED EVERGREENS

A HANDBOOK

- How to Grow Them in the East, West North & South
- Regional Lists
- Landscape Uses
- How to Propagate
- Books & Special Societies

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BROOKLYN BOTANIC GARDEN RECORD
PLANTS & GARDENS

BROAD-LEAVED EVERGREENS

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George Taloumis

TWO POPULAR BROAD-LEAVED EVERGREENS *Below:* Rhododendron 'Scintillation' which, in common with all other members of its genus, is as prized for its flowers as for its foliage. *Above:* Common boxwood, perhaps the ultimate shrub for landscaping where it is hardy, is universally admired for its form and evergreen foliage.

Marjorie J. Dietz

LETTER FROM THE BROOKLYN BOTANIC GARDEN

Broad-leaved evergreens are an important part of the American landscape. Even a casual visitor to the Deep South, where such plants are legion, cannot help but feel the mood conveyed by an ancient live oak or *Magnolia grandiflora*. In southern California, Florida and other very mild areas, hundreds of kinds of subtropical plants from other lands provide a flavor that almost seems indigenous. The Pacific Northwest, where conifers are indisputably the kings of the forest, has gardens resplendent with exotic broad-leaved evergreens—and some very nice native ones, too. Only the Midwest, the mountain states and the very northern perimeter of the country have a paucity of such plants, but this shortage need not be as great as it is if one follows the advice contained in this handbook.

It has been the task of guest editor Brian Mulligan, one of the leading international authorities on broad-leaved evergreens, and his illustrious group of contributors to select the finest of these plants and tell us about them. Mr. Mulligan, an English-trained horticulturist who has made the Pacific Northwest his home for many years, also guest edited the original Brooklyn Botanic Garden Handbook on this subject seventeen years ago. To him and to his contributors, a very warm word of appreciation for bringing us up-to-date.

It is perhaps in the North that broad-leaved evergreens have their greatest meaning. Here, where deciduous plants may be leafless for six months of the year, the winter landscape is usually harsh. However, by the careful selection of broad-leaved evergreens with different kinds of foliage, plus conifers chosen for color and texture contrast, the home grower may have a garden nearly as interesting in winter as in spring or summer. True, no broad-leaved evergreen tree is hardy in the coldest parts of the country, but the imaginative gardener can put one of the best native shrubs to work—mountain-laurel. An old, overgrown specimen can be pruned to make a small tree and has perhaps even more character this way than if allowed to grow naturally as a shrub. In fact, one can do almost everything with mountain-laurel except eat it. (Its leaves are toxic!)

Let us not forget the use of broad-leaved evergreens in bonsai, either. Many of them with diminutive, refined foliage, especially the Japanese holly cultivars and mini-azaleas, are prime candidates for form training in this ancient but increasingly popular Oriental art. A visit to the Botanic Garden's famous bonsai collection will suggest further ideas on how to use a variety of these evergreens.

Wherever you live, let this Handbook be your guide to the wonderful world of broad-leaved evergreens.

Frederick McGourty, Jr.
Editor

Bearberry (*Arctostaphylos uva-ursi*) displays its trailing habit against a garden wall.

George Taloumis

30 OF THE BEST BROAD-LEAVED EVERGREENS

To many gardeners, especially those in regions having cold winters, "evergreens" have long meant only narrow-leaved evergreens—pines, firs, yews and the like, but in the last decade or so there has been an increasing interest in broadleaved evergreens for gardens.

The plants in this list have been selected because of their beauty and general usefulness, the comparatively wide range over which they can be grown, and their hardiness.

Hardiness is indicated by zones (see zone map in centerfold). It must be remembered that such indications are only approximate—within any zone, or even within one garden, there can be many kinds of climate. Moreover, variations among plants occur, and occasional individuals may be found that are much more resistant to cold (or to drought or heat, etc.) than its fellows. Valuable service in finding such plants can be performed by home gardeners who are willing to experiment.

Information in the list has been supplied by Donald G. Huttleston, Clarence E. Lewis, F. G. Meyer, Brian O. Mulligan, Leon C. Snyder, and Donald Wyman.

Bearberry, Kinnikinnick
Arctostaphylos uva-ursi

Hardiness: Very hardy, can be grown in most parts of the United States.

Habit and Use: Creeping plant, makes mats up to about 8 inches. Useful as ground cover or rock garden plant and for holding sandy soils in place.

Flowers and Fruit: Small pinkish flowers in spring followed by red berries.

Leaves: Small, to 1 inch long, shiny, turning bronze in fall.

Should be planted in full sun (but will endure light shade) in well-drained soil; will grow in sand. Difficult to transplant. Start with nursery-grown pot plants, then propagate from cuttings under plastic.

Wintergreen Barberry
Berberis julianae

Hardiness: Hardy in Zone 5 and south; grows only fairly well in northern Illinois, sometimes shows winter injury on Long Island but recovers in spring.

Habit and Use: Shrub growing to 6 feet, very dense. Excellent for hedges.

Flowers and Fruit: Yellowish flowers in clusters in spring; blue-black berries in fall.

Leaves: Spiny-toothed, growing to 3 inches long.

Does best in well-drained light loam soil.

Threespine Barberry
Berberis triacanthophora

Hardiness: Hardy from Zone 5 south; grows quite well on Long Island, well in the Pacific Northwest.

Habit and Use: Shrub growing to 3 or 4 feet. Good for low hedges.

Flowers and Fruit: Creamy white flowers with a reddish tinge in clusters in spring; blue-black berries in fall.

Leaves: Narrow, toothed, up to 2 inches long.

Does best in moist, well-drained light loam soil.

Littleleaf Boxwood
Buxus microphylla

Hardiness: Hardy from Zone 5 south, will stand lower temperatures than common box.

Habit: Shrub growing to 3 feet, sometimes prostrate.

Varieties: *B. microphylla* 'Compacta' is smaller, reaching 12 inches or less after many years' growth.

B. microphylla japonica is taller, to 6 feet, with larger leaves.

B. microphylla koreana grows to about 2 feet; is the most hardy box.

For culture see pages 22 to 24.

Common Box
Buxus sempervirens

Hardiness: Hardy from Zone 5 south, on Long Island the tips may be injured in winter.

Habit: Shrub or tree growing to 25 feet.

Varieties: *B. sempervirens* 'Suffruticosa' is small, very slow growing, with leaves up to ¾ inch long.

For culture see pages 22 to 24.

Heather
Calluna vulgaris

Hardiness: Hardy in Zone 4 and south.

Habit and Use: Small shrubs, some of which will grow to about 3 feet, while others form carpets only 6 to 8 inches tall. Good for ground cover or rock garden.

Camellia 'Sweetheart' has pink flowers.

Marjorie J. Dietz

Flowers: Very small, in often showy spikes 6 to 8 inches long, in summer. Purplish but ranging from white to red in the varieties.

Leaves: Minute, scale-like, turning bronze in autumn in some varieties.

Requires a light, sandy, acid soil that is not rich. On rich soil plants become leggy and die. Will not stand severe drought. Will grow in some shade, but needs sun for blossoming. The closely related heath (*Erica*) is similar in appearance and culture.

Common Camellia
Camellia japonica

Hardiness: Commonly rated as hardy in Zone 7 and south, but some varieties are hardy as far north as Yonkers, New York and Long Island.

Habit and Use: Shrub or tree to 25 feet. Superb specimen plants or screen plantings can be espaliered.

For culture, varieties, and uses see pages 50-54.

Sasanqua Camellia
Camellia sasanqua

Hardiness: Hardy from Zone 7 south, probably a little less hardy than *C. japonica*.

Habit: Shrub or tree growing to 20 feet.

For culture, varieties, and uses see page 55.

Most heathers (*Calluna*) bear their flowers in midsummer. They are low-growing shrubs with narrow, needle-like evergreen foliage. Similar are the heaths (*Erica*), but some of its species and varieties flower in fall and winter.

Marjorie J. Dietz

Garland Flower
Daphne cneorum

Hardiness: Hardy at least as far north as Zone 4, can be grown in parts of North Dakota (Zone 3) with some protection.

Habit: Low shrub, sometimes growing to 6 feet, but usually less.

Flowers: Clusters of small, rose-pink, fragrant flowers in spring.

Leaves: Small, about 1 inch long.

Will do well in either acid or alkaline soil; roots should be kept cool and moist.

Thorny Elaeagnus
Elaeagnus pungens

Hardiness: Hardy from Zone 7 south; can be grown in sheltered spots as far north as New York City.

Habit: Small tree or shrub growing 12 to 15 feet tall.

Flowers and Fruit: Small, very fragrant flowers in October and November. Small fruit turning red in spring.

Leaves: Glossy, dark green, silvery underneath.

Will do well in difficult places; likes full sun. The variety *E. pungens* 'Maculata' has large golden-yellow blotch in centers of leaves, is useful for winter color. Other variegated forms also available.

Winter Creeper
Euonymus fortunei

Hardiness: Hardy from Zone 5 south and in sheltered spots a little farther north.

Habit and Use: Varies from clinging vine to sub-shrub. Useful for ground cover, wall cover, in foundation plantings or as specimen plants, depending on variety.

Flowers and Fruit: Flowers insignificant, rare except in two varieties; fruit showy in the two varieties which bear abundantly.

Varieties: E. *fortunei* 'Carrieri' is shrubby, has very glossy, dark leaves to 2 inches long; fruits abundantly, red berries with pink capsules.

E. fortunei 'Coloratus' spreads, grows to about 1 foot, makes excellent ground cover. Leaves to 1 inch long, turn purple-red in fall and winter.

E. fortunei 'Vegetus' is semi-shrubby, grows to about 5 feet. Leaves rounded, to 1½ inches long. Called evergreen bittersweet because of its abundant orange fruit.

Euonymous does not require acid soil, will tolerate shade. Watch out for scale (see HANDBOOK ON GARDEN PESTS, page 67).

English Ivy
Hedera helix

Hardiness: Hardy from Zone 5 south, it can be grown in protected areas in Zone 4.

Habit and Use: Vine, clinging to walls and other supports or trailing on ground, may reach 90 feet or more. Useful on walls, fences, and as an evergreen ground cover.

Flowers and Fruit: Flowers greenish, in round clusters; fruit black.

Leaves: Dark green, 3- to 5-lobed, to 4 inches long. Not lobed on mature fruiting branches.

Variety: *H. helix* 'Baltica' is somewhat smaller leaved and hardier. Many other varieties available, differing mostly in leaf size and shape.

English Holly
Ilex aquifolium

Hardiness: Hardy from Zone 6 south, except in Florida.

Habit: Tree growing to 40 feet in height.

For culture and uses see pages 29 to 31.

Chinese Holly
Ilex cornuta

Hardiness: Hardy Zone 6 south; some strains can be grown in parts of Zone 5 with protection, although it is not proving as hardy in St. Louis, Missouri (middle of Zone 5) as first thought to be. At Ottawa, Kansas, it has reportedly withstood summer temperatures reaching 109° to 118°F.

Habit: Shrub growing to 9 or 10 feet.

Flowers and Fruit: Flowers inconspicuous, followed by bright red berries which last through the winter.

Leaves: Dark green, shining, usually 5-spined. In variety 'Burfordii' they are darker, mostly with one spine.

Culture as for other hollies, see pages 25 to 28.

Japanese Holly
Ilex crenata

Hardiness: Hardy in Zone 6 and south, probably some strains farther north. Persists under snow in Minneapolis, Minnesota.

Habit: Shrub growing to 20 feet.

George Taloumis

Evergreen euonymous 'Emerald Pride' makes a formal but gracefully curved hedge along a mixed border of shrubs and perennials.

Left: Japanese holly (*Ilex crenata*), especially 'Convexa' and many other selected forms, is a superb broad-leaved evergreen, as useful for landscaping over much of the North as boxwood is in the South. *Below:* Canary Island ivy (*Hedera canariensis*) serves as both ground cover and low hedge in this California garden.

Marjorie J. Dietz

Helen S. Witty

Flowers and Fruit: Inconspicuous flowers; small black berries in fall.

Leaves: Dark green, shining, ½ to 1½ inches long.

Varieties: *I. crenata* 'Convexa' grows to 3 or 4 feet, is twice as broad as high.

I. crenata 'Hetzii' much like above but leaves are elongate and it is perhaps hardier.

I. crenata 'Helleri' is dwarf, growing only to 1 to 1½ feet.

I. crenata latifolia has more rounded leaves.

I. crenata 'Microphylla' is most hardy, has leaves less than ½ inch long.

I. crenata 'Rotundifolia' has round leaves, tolerates sun better than others in Midwest.

For uses and culture see pages 25 to 28.

Inkberry
Ilex glabra

Hardiness: Hardy into Zone 4, although at Minneapolis it kills back to the ground, coming up again from the base.

Habit and Use: Shrub to 10 feet, usually less. Can be used as specimen plant or for screen plantings. Thrives in cities.

Flowers and Fruit: Flowers inconspicuous, followed by small black berries in fall.

Leaves: Dark green, lustrous, 1 to 2 inches long.

American Holly
Ilex opaca

Hardiness: Hardy in Zone 5, and possibly some strains in Zone 4.

Habit: Tree growing to 50 feet.

For varieties, culture, and uses, see pages 25 to 28.

Mountain-laurel
Kalmia latifolia

Hardiness: Hardy in Zone 4 and south, has been grown as far north as Minneapolis with shade and good snow cover.

Habit and Use: Shrub growing to 10 feet or more. Excellent for foundation plantings, on banks, and in natural plantings.

Flowers: Pink and white flowers in clusters produced abundantly in late spring or early summer.

Leaves: Shiny, to 5 inches long.

Requires acid soil. Will grow in shade, but needs sun to flower well.

George Taloumis

Imaginative use of a fine native shrub is shown in this massed planting of inkberry (*Ilex glabra*) under tall pine trees. The owners have eliminated a lawn by planting English ivy (*left*). Additional ground cover is provided by the needles from the pine trees.

Drooping Leucothoë
Leucothoë fontanesiana (catesbaei)

Hardiness: Hardy in Zone 4 and south, and has been grown as far north as Minneapolis with shade and good snow cover.

Habit and Use: Shrub growing to 6 feet, useful in borders, not so good as specimen plant.

Flowers: Small white flowers in attractive drooping clusters 3 inches long in late spring.

Leaves: Lustrous, dark green, to 7 inches long.

Needs light, peaty, acid soil.

Oregon Holly-grape
Mahonia aquifolium

Hardiness: Rated hardy in Zone 5 and south, but can be grown in southeastern Nebraska, and near Chicago, Illinois, both in Zone 4.

Habit and Use: Shrub 3 or more feet high. Makes good thicket or tall ground cover.

Flowers and Fruit: Flowers small, yellow, fragrant, in spikes in spring. Edible fruit in summer, blue-black, grape-like berries.

Leaves: Glossy, dark green, compound with 6 to 9 leaflets. Leaflets are spiny, much like holly leaves, may turn purple in fall.

Grows best in partial shade, but in most regions needs protection from drying winds.

Leatherleaf Mahonia
Mahonia bealei

Hardiness: Hardy in Zone 6 and south.

Habit and Use: Shrub growing to 12 feet; good specimen plant.

Flowers and Fruit: Lemon yellow flowers, fragrant, in clusters in spring, followed by bluish-black fruit.

Leaves: Compound, up to 16 inches long. Leaflets have fewer spines, are less glossy than those of *M. aquifolium.*

Prefers acid soil, partial shade.

Holly Osmanthus
Osmanthus heterophyllus (ilicifolius)

Hardiness: Hardy in Zone 6 and south; has been grown on Long Island for 40 years.

Habit and Use: Shrub growing 18 to 20 feet high. Can be grown as handsome specimen plant, or clipped for hedge.

Flowers and Fruit: Flowers small, fragrant, in fall; bluish-black berries.

Leaves: Shining, dark green, spiny, resembling those of holly.

Can be grown in either sun or partial shade, does better in acid soil.

Japanese Spurge
Pachysandra terminalis

Hardiness: Stated to be hardy from Zone 5 south, it can be grown in northern Illinois (Zone 4) and in Minnesota and North Dakota (Zone 3), so is worth trying in these zones.

Habit and Use: Creeping, grows to 12 inches tall. Very valuable ground cover.

Flowers and Fruit: Flowers small, white, in spring; fruit white, in fall.

Leaves: Toothed, dark green, lustrous, grow in whorls.

Grows best in acid soil and in partial shade.

Canby Pachistima
Pachistima canbyi

Hardiness: Hardy in Zone 4 and south, can be grown in North Dakota and Minnesota.

Habit and Use: Low shrub growing 1 or 1½ feet. Good for ground cover, for borders and low hedges, and in foundation plantings. Colonies can be allowed to naturalize in Woodland gardens.

Flowers and Fruit: Insignificant.

Leaves: Narrow, to 1 inch long, dark green turning bronze in fall.

Requires acid soil and shade. Easy to propagate by division in spring, or by cuttings in summer or winter under plastic. (The spelling of the generic name has been recently changed to *Paxistima.*)

Marjorie J. Dietz

The sweet-scented white flower clusters of drooping leucothoë (*Leucothoë fontanesiana*) (*left*) and evergreen foliage and shrub habit (*right*). Shrubs of leucothoë that have become lanky and invasive because of suckering can be reshaped and restrained by cutting the stems back to the base in spring to force new, compact growth.

Mountain Pieris
Pieris floribunda

Hardiness: Hardy in Zone 4 and south.

Habit and Use: Shrub growing to 6 feet. Useful in foundation and screen plantings, or as specimen plant.

Flowers: Small, white, nodding, in erect clusters in spring.

Leaves: Shining, to 3½ inches long.

Does best in light soil and partial shade.

Japanese Pieris
Pieris japonica

Hardiness: Hardy in Zone 5 and south.

Habit: Shrub sometimes growing to 10 feet or more.

Flowers: Small, creamy white, in drooping clusters up to 5 inches long, in spring.

Leaves: Dark green, lustrous, to 3½ inches long.

Prefers acid soil, partial shade. Will grow in quite heavy shade, but blooms better if it gets some sun. Too much exposure to sun makes plants more susceptible to infestation from lacebugs. Stands city conditions well.

Scarlet Firethorn
Pyracantha coccinea

Hardiness: Hardy in Zone 6 and south.

Habit and Use: Shrub or tree growing to 20 feet. Useful for espaliering on walls, as specimen plants (in warm regions), can be trimmed for hedge although the necessary pruning for this will reduce the amount of fruit produced.

Flowers and Fruit: Flowers small, white, in flat clusters in early summer; fruit red or orange, abundant, showy in fall and winter.

Leaves: Small, may fall late in season in northern parts of range.

Varieties: *P. coccinea* 'Lalandei' has orange-red fruits, is more vigorous and a little hardier than the species. It has been grown in Minneapolis, where it kills back to some extent (see page 76). Worthy of trial in sheltered spots or against warm walls as far north as Zone 3. Newer hybrids are 'Orange Glow', 'Shawnee', and 'Watereri'.

Firethorns can be grown in neutral or slight alkaline soil.

George Taloumis

Prickly evergreen foliage and yellow flower clusters of the leatherleaf mahonia (*Mahonia bealei*).

Rhododendron and Azalea
Rhododendron spp.

Over 2,000 species, varieties and hybrids of *Rhododendron* are known, at least three quarters of which are evergreen. The plants commonly called azaleas as well as those known as rhododendrons belong to the genus *Rhododendron.* There is no single sharp difference between them, but in general most rhododendrons are evergreen, most azaleas lose their leaves; leaves of azaleas are usually small and often have short hairs, those of many rhododendrons are large and have dots or scales beneath; the flowers of azaleas usually have five stamens, those of rhododendrons ten or more.

All require light acid soil (see page 66) for preparing acid soil in limestone regions).

Listed here are but five of the more hardy species. See articles elsewhere in this issue for culture, varieties, uses, etc.

Carolina Rhododendron
Rhododendron carolinianum

Hardiness: Rated hardy from Zone 5 south, but is satisfactory in Chicago area (Zone 4); is worth trying in protected sites in other parts of this zone.

Habit: Shrub growing to 6 feet.

Flowers: Pale rose-purple, in late spring.

Leaves: Up to 3 inches long, brown on underside.

Catawba Rhododendron
Rhododendron catawbiense

Hardiness: Zone 4 south.

Habit: Shrub or tree growing to 20 feet.

Flowers: Lilac-purple, spotted with olive-green (white in variety *album*) in early summer.

Leaves: Up to 5 inches long.

Rosebay Rhododendron
Rhododendron maximum

Hardiness: Zone 3 south.

Habit: Tree or shrub growing to 35 feet.

Flowers: Rose to purple-pink, spotted with green, in summer.

Leaves: Up to 10 inches long.

Keiske Rhododendron
Rhododendron keiskei

Hardiness: Zone 5 south.

Habit: Shrub growing to 10 feet.

Flowers: Pale yellow, in early spring.

Leaves: Up to 2½ inches.

Japanese pieris (*Pieris japonica*) has drooping flower clusters in early spring. *Below:* Mountain pieris (*P. floribunda*) is readly distinguished from the Japanese species by its erect rather than drooping clusters.

Marjorie J. Dietz

George Taloumis

A group of evergreen azaleas that have been naturalized in a woodland. Most evergreen azaleas are so floriferous that during blooming time the evergreen foliage is totally hidden.

Marjorie J. Dietz

Kurume Azaleas
Hybrids of *Rhododendron obtusum* and *R. kiusianum*

Hardiness: Variety 'Amoenum', from Zone 5 south; the many hybrids from Zone 6 south to Zone 9 south.

Habit: Shrub growing to 3 feet.

Flowers: Many colors, both double and single; in variety 'Amoenum' they are bright magenta.

Leaves: Up to 1 inch long, only semi-evergreen in northern part of range.

Smirnow Rhododendron
Rhododendron smirnowii

Hardiness: Zone 4 south.

Habit: Shrub growing to 18 feet.

Flowers: White to rose-red, in late spring.

Leaves: Up to 6 inches long, woolly beneath.

Leatherleaf Viburnum
Viburnum rhytidophyllum

Hardiness: Hardy in Zone 5 and south, can be grown in parts of Zone 4, may not be completely evergreen in northern part of range.

Habit: Shrub growing to 9 feet.

Flowers and Fruit: Flowers small, white (pink in variety *roseum*), in flat clusters. Fruit, small red to black berries.

Leaves: To 7 inches long, shining, dark green, interesting wrinkled surface, woolly underneath.

Should have rich, well drained soil.

Common Periwinkle, Myrtle
Vinca minor

Hardiness: Hardy from Zone 4 south, but worth trying in parts of Zone 3, as it can be grown in parts of North Dakota.

Habit and Use: Trailing, one of the most useful ground covers.

Flowers: Lilac-blue, in spring.

Leaves: Lustrous, dark green.

Does very well in shade, but will also grow in sun; will grow on any but the poorest of soils.

DWARF EVERGREENS FOR THE ROCK GARDEN

. . . some can be used elsewhere as borders, low hedges, or ground covers

Alys Sutcliffe

SEVERAL broad-leaved evergreens are suitable additions to the rock garden. In spring and summer their foliage serves as a foil for other plants, and in winter the green or bronze leaves brighten an otherwise dead-looking garden and remind us that there is life there, even in the dormant season. Some of these dwarf broad-leaved evergreens pay extra dividends of attractive flowers.

Many of the plants listed below, like their larger counterparts, prefer or even demand acid soil. For gardeners whose soil is neutral or slightly alkaline, the varieties of Japanese holly, barberry, honeysuckle, box, and teucrium are recommended.

In the Pacific Northwest there are many dwarf rhododendrons for the rock garden. The ones listed here have proved hardy in the East, and are worth trying at least as far north as Cape Cod.

Rarely thought of as broad-leaved evergreens are a number of plants native to the northeastern states. They include some of the most attractive specimens for the small shady rock garden, or a shady corner of a large garden. All are hardy, even in northernmost states, and add a welcome touch of green to the winter woods.

Two of the best known are trailing-arbutus (*Epigaea repens*) and partridge-berry (*Mitchella repens*). Similar in its trailing habit, but perhaps not so well known, is creeping snowberry (*Chiogenes hispidula*). These will grow best in well-drained woodland soil and need some shade. Another trailing evergreen which is very useful for sandy soil and rocky places in full sun is bearberry or kinnikinnick (*Arctostaphylos uva-ursi*). Alpine-azalea (*Loiseleuria procumbens*) is a truly northern plant which grows into Newfoundland and northward. A truly dwarf

The alpen-rose (*Rhododendron ferrugineum*) is slow-growing and compact and worth growing for its foliage alone. Its flowers are produced rather sparsely —in the Northeast anyway.

Marjorie J. Dietz

White flower spikes of galax (*Galax rotundifolia,* formerly *G. aphylla*) push through fern fronds that nearly hide the leathery-textured heart-shaped leaves. The foliage in winter becomes red-tinged or bronze.

form of the bog-laurel, *Kalmia polifolia* var. *microphylla,* is native to the high mountains of Colorado, but given the right conditions—acid, moist soil—can be persuaded to grow elsewhere.

Three other native American plants which can be included in this group are pipsissewa (*Chimaphila maculata*), Oconee bells (*Shortia galacifolia*), and galax (*Galax aphylla*). While not perhaps strictly woody plants, the creeping rootstocks of these are woody, and their evergreen leaves give them a place as broad-leaved evergreens.

Many of these natives are very difficult to transplant from the wild. It has been found that much better success is had if plants are obtained from nurserymen who specialize in growing them. For this reason, and to conserve these plants in their native habitats, it is recommended that they be purchased, not dug up from the woods.

LIST OF DWARF BROAD-LEAVED EVERGREENS

Bearberry *(Arctostaphylos uva-ursi)*
Trailing, likes full sun, will grow in sandy soil. White or pinkish flowers in spring. Excellent ground cover.

Barberry *(Berberis)*
Two species suitable for rock gardens. *B. candidula* is a dwarf shrub with leaves to 1¼ inches long, white beneath. *B. verruculosa* grows to 3 feet, has glossy dark green, spiny-toothed leaves and small yellow flowers.

Boxwood (*Buxus*) See page 22.
Two varieties are good for rock garden use. *Buxus microphylla koreana* grows to 2 feet, has open upright growth, while *B. microphylla* 'Compacta' forms a compact mound somewhat like *Ilex crenata* 'Helleri' but with bright green shiny leaves.

Pipsissewa *(Chimaphila)*
Two species, *C. maculata* and *C. umbellata cisatlantica,* grow to about 10 inches. *C. maculata* has leaves with shiny teeth, variegated white along the veins.

Snowberry *(Chiogenes hispidula)*
Creeping, with leaves about ⅓ inch long, white flowers in the spring, followed by white berries.

Trailing-arbutus *(Epigaea repens)*
Creeping, leaves to 3 inches long. Prized for its extremely fragrant pink and white flowers very early in the spring. A Japanese species, *E. asiatica,* is similar but with more oblong leaves.

Galax (*Galax rotundifolia,* formerly *G. aphylla*)
Stiff, shining, heart-shaped leaves, as much as 5 inches across, turning beautiful bronze in autumn. Spikes of small white flowers in late spring.

Japanese Holly (*Alex crenata*) See pages 7, 26.

Many varieties of Japanese holly can be used in rock gardens. *Ilex crenata* 'Helleri' is suitable for large gardens. It has tiny dull green leaves and grows in a spreading compact mound.

Bog-laurel, Bog Kalmia *(Kalmia polifolia)*

This relative of the well-known mountain-laurel is a good rock garden subject for reasonably moist soil. It grows to about 24 inches. The flowers are rose-purple. *K. polifolia microphylla* has leaves only about ¾ inch long and grows only 8 inches in height.

Sand-myrtle (*Leiophyllum buxifolium*)

Another member of the heath family for acid, rather sandy soil in full sun. Excellent for the rock garden because of its compact growth habit—its height remains at about 18 inches—and small, neat glossy foliage. Clusters of small white flowers appear in mid-spring.

Honeysuckle *(Lonicera)*

Lonicera pileata is a very hardy evergreen honeysuckle which will sprawl over the rocks. It has shiny leaves and whitish fragrant flowers. Of more delicate texture is *L. nitida,* a small upright shrub with small, shiny, bronze leaves. It is not quite so hardy as the other.

Alpine-azalea *(Loiseleuria procumbens)*

This northern plant makes mats 6 to 8 inches high of leaves mostly less than ¼ inch long and has very small white or rose flowers.

Partridge-berry *(Mitchella repens)*

Creeping, with leaves to ¾ inch long, dark green and shiny, often with white veins. The small white flowers are twinned, and are followed by red berries.

Rhododendron

R. carolinianum, only suitable for the large rock garden as it reaches 6 feet. Leaves to 3 inches long, pale rose-purple to white flowers. 'Purple Gem', a hybrid from this species is of suitable stature for most rock gardens.

R. chryseum grows to 2½ feet. The leaves are only about ½ inch long; the flowers are yellow.

R. fastigiatum reaches to 3 feet, has lilac-rose flowers.

R. ferrugineum also grows to about 3 feet. The pink flowers are produced in early summer, usually in June in the northeast.

R. impeditum has short branches and reaches only about 20 inches in height. The leaves are less than ½ inch long, the flowers purple-blue.

R. racemosum, one of the most attractive of this group, grows eventually to about 6 feet, but there appear to be many forms in cultivation that remain for years around 3 feet or so. It has small pink, bell-shaped flowers.

R. russatum reaches about 3 feet in height. It has flat clusters of flowers of deep purple-blue color, with white throats.

Oconee Bells *(Shortia galacifolia)*

Bronzy, rounded leaves up to 3 inches in diameter grow up to 8 inches above a creeping rootstalk. White flowers in spring.

Reeves Skimmia *(Skimmia reevesiana)*

Hardy along the coast as far north as New York City, this 2-foot shrub has white flowers and dull red fruit.

Germander *(Teucrium chamaedrys)*

Germander grows to about 1 foot in height, has ¾-inch, toothed leaves. The red-purple or rose flowers are borne in loose spikes. Good for borders or low hedges.

Aristocratic trees for the home garden

THERE IS VARIETY IN EVERGREEN MAGNOLIAS

J. C. McDaniel

THE Spanish, the French and the English took the southern magnolia (*Magnolia grandiflora*) from the South Atlantic and Gulf Coasts to their homelands during the Colonial period. Adaptable to widely varied soil and climatic conditions, it has since become the favorite American flowering tree in most warm-temperature to subtropical areas around the world. Until recently, most named cultivars (cultivated varieties) of this species were English and French selections but now, since variations have received attention, there are at least as many American cultivars, selected both within and beyond the original native range. Other evergreen *Magnolia* species, American and Chinese, and some hybrids, are promising for several regions but are less often seen in our gardens or nurseries.

A majority of the world's *Magnolia* species are evergreens, but only a very few of the approximately 46 or more evergreen species (mainly tropical) are cultivated anywhere. *M. grandiflora* is by long odds the most popular one. The shiny-leaved *M. nitida* from Yunnan and southeast Tibet grows in southern Cornwall, England, but has seldom been successfully propagated. *M. delavayi,* also from Yunnan, with inferior flowers but impressive 8-14-inch long leaves, is easily cutting-propagated, and is justifiably gaining popularity in southern England and along our own Pacific Coast as a worthwhile ornamental. Three Mexican and one Guatemalan species are in U.S. trials but can probably be grown outdoors only to Zone 8 and, like other Latin American magnolias, are passed over for planting in their native countries in favor of the more showy-flowered *M. grandiflora.* The other sometimes-evergreen U.S. species is *M. virginiana,* much more often seen in gardens in its northern typical variety. *M. virginiana* var. *australis,* actually the more prevalent variety as a native tree, can, depending on the clone, be deciduous by December, semi-evergreen, or fully evergreen, so it merits some discussion here. Then there are the hybrids, mostly combining *M. virginiana* with *M. grandiflora.* Many of the best cultivar forms in *M. grandiflora* appear to me to be descended from natural hybrids with *M. virginiana australis,* that occurred long before Oliver M. Freeman in 1937 reported his controlled crosses of *virginiana* x *grandiflora.*

Southern Magnolia

Adventurous gardeners have tried, and often succeeded, in growing *M. grandiflora* far north (and south) of its native range from southeast North Carolina to eastern Texas and central Florida. Seedlings and some cultivars are now seen occasionally flowering up to the northern parts of Zone 5 (Arnold Arboretum Map), including the shores of Lake Erie. At this stage, we cannot say for sure which are the hardiest cultivars, since no inclusive test has tried many of them together in the same locality in or north of Zone 5. Those selected or successfully cultivated in middle latitudes would be initially more promising candidates than some newer ones not previously tested outside California or the lower South. On this basis, 'Cairo', 'Charles Dickens', 'Edith Bogue', 'Empire State', 'Exmouth', 'Freeman', 'Galissonniere', 'Praecox Fastigiata' and 'Victoria' would all be promising for cold hardiness. Others may prove equally hardy.

Farther south, the discriminating planter has a potentially wider field of choice. Since hardiness is then not such a problem, he can expect better results with nearly any cultivar than with the cheaper

but often nondescript *M. grandiflora* seedling.

Cultivars in *M. grandiflora,* selected for superior foliage, flowers and tree form, or supposed hardiness, have been propagated asexually in England since 1737, and are becoming more prominent in recent American propagation for Zone 5 and warmer areas. They are greatly to be preferred for quicker flowering and for uniformity over the usually offered variable seedlings. The following list includes both American and European selections believed to be in current propagation, although some are not commonly offered. Many older named cultivars are extinct, or nearly so.

'Alabama Everblooming'—leaves lanceolate; long-flowering, but probably inferior to 'Cairo' in more wintry climates.

'Baby Doll'—slow growing, small-leaved, from Florida.

'Baldwin'—dark-foliaged, upright, late-flowering Alabama selection.

'Cairo'—exceptionally shiny lanceolate leaves with light tomentum, comparable to *M. nitida* for glossiness; handsome flowers, long-flowering; ripe fruits reddish; broad-columnar tree. Selected in Cairo, Illinois.

'Charles Dickens'—spreading specimen tree (lower limbs touch ground), with wide, well-indumented obovate leaves, large flowers and very large, very red-coloring fruits in Tennessee. A tetraploid, possibly with *M. macrophylla* ancestry, so it has interesting breeding possibilities. (Ordinary *M. grandiflora* is hexaploid.)

'Edith Bogue'—selected in Montclair, New Jersey; relatively hardy, and easy to propagate.

'Empire State'—selected long ago on Long Island by H. Harold Hume; a large-flowered, long-leaved cultivar that should be hardier than average. Known now at Tampa, Florida and under test at Brooklyn Botanic Garden.

Brian Gage for Saratoga Horticultural Foundation

Magnolia grandiflora 'San Marino' has rather ruffled evergreen foliage. It is patented.

'Exmouth' (synonyms: *exoniensis, lanceolata,* etc.)—the most popular English cultivar and a good one in America, more free flowering, compact and slower-growing than most seedlings. Sometimes has "double" flowers with up to 20 or more petals, but 9 is the usual number in this and most *M. grandiflora.*

'Ferruginea'—one or more English clones with red-brown indumentum on leaf undersides are propagated under this name. Some American selections have better flowers and are equally "rusty."

'Freeman'—*M. virginiana* x *M. grandiflora* hybrid of rather narrow upright growth. Leaves most like *grandiflora* but leaves and flowers are smaller. Partially fertile.

'Galissonniere' (Galissoniensis)—French selection with handsome glossy leaves, reputedly hardy.

'Griffin'—small leaves, large 12-petaled flowers over long season, red fruits. Tree compact-spreading.

'Goliath'—light glossy green, blunt

Flower and foliage of *M. grandiflora* 'Samuel Sommer'. The leaves are large and glossy.

Maunsell Van Rensselaer

Flower bud of magnolia 'Samuel Sommer'.

leaves. Large flowers over a long season in England. Isle of Guernsey selection. High rating at U.S. National Arboretum.

'Little Gem'—small glossy leaves, good-sized flowers. A North Carolina selection.

'Madison'—lanceolate leaves, less shiny than 'Cairo'; free flowering over long season, very vigorous grower in lower South. Selected near Huntsville, Alabama.

'Majestic Beauty'—patented; notable for large, rather thin leaves. Southern California selection.

'Nannetensis'—French selection, with flowers perhaps more frequently "double" than in 'Exmouth', but variable.

'Praecox Fastigiata' (Kingsville Fastigiate)—very floriferous, medium to small flowers over long season; tree narrow, slow-growing. Henry Hohman's seedling of 'Praecox', raised at Kingsville, Maryland, and good at Barnes Arboretum near Philadelphia.

'Russet'—patented. Small leaves, intensely orange-brown tomentose beneath and held rather erect. In Florida it is a less dense tree than most.

'Saint Mary'—leaves more glossy and browner beneath than usual. Has long been the most propagated cultivar in U.S., but now seems less desirable than 'Cairo' and 'Samuel Sommer'. Has been flowered at Detroit, Michigan.

'Samuel Sommer'—patented. Growth erect, leaves rather large and glossy, brown-hairy beneath. Good flowers.

'San Marino'—patented. Rather horizontal branches; ruffled leaves with light tomentum. Selected as a California street tree.

'Satin Leaf'—leaves long-petioled elliptic or nearly so, intensely red-brown tomentose underneath; flowers large; a Florida selection. (A similar, but not identical selection is known as 'Ruff'.)

'Victoria'—dark-foliaged, with considerable tomentum underneath; flowers rather small. From Victoria, B.C., Canada, and a current favorite in Oregon where it seems resistant to occasional autumn freezes.

In addition to the named cultivars, some southeastern nurseries are propagating unnamed local selections from cuttings. Others grow seedlings from choice named or unnamed trees, which

Magnolia grandiflora 'Russet' is another patented magnolia with small, rather narrow leaves.

E. A. Grensted for Saratoga Horticultural Foundation

give considerably less uniform products than clonal propagation, though averaging better than the usual seedling. Most *grandiflora* clones can be rooted from cuttings, some more readily than others. Budding or grafting is usually on seedlings of this species as stocks, although *M. kobus* stocks have occasionally been used.

M. virginiana var. australis

Var. *australis* is usually a more upright tree than the northern sweetbays, growing in the South to 60 feet or taller. Var. *australis* flowers open later in the afternoon and have a more intense fragrance than those of typical var. *virginiana.*

'Henry Hicks', the principal named cultivar of evergreen sweetbay magnolia, was selected at Swarthmore, Pennsylvania, and has been hardy at Brookville, Pennsylvania and Urbana, Illinois. It is propagated by grafting on either variety of *M. virginiana.* It is vigorous as a young tree, but may seldom exceed 30 ft. at maturity in the North.

Other clonal selections of better than usual evergreen forms may be appearing soon. I am growing, at Urbana, Illinois, one selected from the most elevated known native outpost of this variety (1,600 ft.) near Crofts Chapel, Turtletown, Tennessee, which has smaller but more glossy leaves than 'Henry Hicks', and am obtaining seedlings from crosses, since var. *australis* flowers are self-incompatible. I have some intervarietal hybrids between 'Henry Hicks' and a shrubby selection of var. *virginiana,* which are very precocious and promise to yield some intermediate cultivars. Crosses have also been accomplished between the larger-flowered but more nearly deciduous form of var. *australis* occurring in Texas-western Louisiana, and the fully evergreen but more tender Florida Everglades race of this variety. The latter has yielded some dwarf hybrids with northern sweetbay.

Because of their more slender petioles, the leaves of *M. v.* var. *australis* in exposed midwestern situations are subject to more breakage in winter winds, especially when ice-coated, than those of *M. grandiflora.* I have obtained hybrids of typical *M. virginiana* with pollen of both the 'Freeman' hybrid and 'Charles Dickens', which have stouter evergreen leaves than *virginiana,* but glaucous beneath, and these produce sterile flowers of intermediate size. One or more, hardy at Urbana, may be selected for naming in the coming years if proven satisfactory.

SUCCESS WITH BOXWOOD

What to do and what not to do

A. G. Smith, Jr.

THE DEATH of boxwood plants during the past three decades represents a loss of thousands of these evergreens and a waste of untold sums of money. Much of this loss was unnecessary. The following statements are offered as a partial solution to this costly problem.

Boxwood in its various forms is a valuable ornamental plant in many sections of the United States. Contrary to general belief, it is a vigorous plant and requires but little care. Its development varies with the species or variety and with the conditions under which it is growing. There are many living specimens which are known to be more than 100 years old.

No diseases of importance affect boxwood; however, numerous fungi may be found on the leaves and stems after these parts have been weakened or killed by other causes. The elaborate steps which have been taken to prevent or control the so-called diseases have been one of the major causes of the widespread losses of the plants.

In our yard at Blacksburg, Virginia, there is a hedge of tree boxwood and a number of dwarf plants, all of which were grown from "diseased" branches that were sent from different sections for help in identification and control of the diseases. These twigs were rooted in the shade of our garage and, later, planted where they could be kept under observation.

Most boxwood troubles are man-made. In a fairly good environment this grand old plant can take care of itself, so long as it is not attacked by leaf miners. Dwarf box appears to be immune to this pest.

A study, extending over many years, shows that, with rare exceptions, all boxwood troubles are caused by one or more of the following:

1. **Damage to the roots by**
   - Digging in the root area by man or animals.
   - Planting too deeply or settling later of root ball.
   - Applying excessive amounts of fertilizer.
   - A heavy mulch.
   - Setting plants in tight soil with no drainage provided at bottom or sides.
   - Soil washing away from the plants and exposing the roots.
   - Dead leaves accumulating at the bases of dwarf plants.
   - Excessive watering.
   - Matting of ivy, periwinkle, etc., around the plants.
2. **Damage to leaves and branches by**
   - Leaf miners on tree (or "American") box.
   - Accumulation of soot and dust on foliage; effect of smoke and gases.
   - Shade of plants or buildings.
   - Toxic chemical sprays.
3. **Damage to the entire plant by**
   - Clipping instead of thinning.
   - Snow or sleet bending weak branches.
   - Winter-killing. Usually the result of over-feeding or poor drainage.
   - Salt from coastal storms or from well water.
   - Total lack of water.

All boxwood plants suffer a loss of feeder roots when they are transplanted. If a large plant is moved, after having grown in one place for a number of years, something like 90 per cent of its feeder roots are lost. Then it becomes necessary for perhaps 10 per cent of the roots to support the plant, which still has 100

Forrest W. Patton

Dwarf boxwood, as it appeared at Stratford Hall on May 3, 1965. It is even more beautiful now. These plants were moved from the East Garden at Stratford in 1937; and with them went the soil containing all of the species of nematodes and "diseases" that were thought to be killing so many plants in the East Garden. Since 1937, these grand old plants have missed the numerous treatments that really caused the death of so many valuable boxwood plants on the other side of the wall.

per cent of its top. This is the point at which the plant goes into "shock." Instead of thinning the top and thereby establishing a semblance of a balance between roots and top, the zealous gardener will try almost everything in the way of shade, fertilizers, mulches, heavy watering and sprays. He thus creates an environment that may prove fatal to the boxwood.

Transplanting

Every effort should be made to save as much of the feeder (surface) roots as possible when the boxwood is being transplanted. Equal care should be taken to prepare its new site so that it will have ample drainage in the root area.

Place the ball on a firm bottom and level with the surface. The fill-in soil should be a loamy mixture without fertilizer or manure. This dry or moist soil should be tamped under and around the ball as the hole is filled. Then make a temporary ring of soil around the outside of the hole to prevent the water from running away. Let the water run slowly on the center of the ball until it and the fill-in soil are both thoroughly moist. Water as necessary to prevent drying. Remove the soil ring after a few months.

If the plant has been properly handled it will not have to be shaded. The matter of taking out some of the weak branches and shortening others will depend on the size of the plant, its condition and the percentage of feeder roots that are saved.

The pruning of boxwood may be an important operation for the following reasons:

1. To keep the plants at the desired size.
2. To develop a strong framework against damage from snow and ice.
3. To improve the condition of a plant that has stopped growing at the top.
4. To compensate for the loss of roots when transplanted.

Start by removing the weak and crowded branches. Continue the thinning until air and sunlight are admitted to the interior of the plant. Heavy cutting should be done only in the spring before the new growth starts. Do moderate thinning whenever it is most convenient.

(continued)

Boxwood can compete successfully with grasses and weeds, if these plants are kept mowed. Any attempt to dig them out will injure the roots of the boxwood. Such injury usually occurs when flowers are planted in borders which are edged with boxwood.

Many cultivars of boxwood (*Buxus sempervirens*) are being grown and distributed. I have grown many thousands of these plants from seed and have found, when examined closely, that no two seedlings are exactly alike. They vary in many ways but especially in their response to weather conditions.

After a severe late winter freeze one year, I examined a planting of about 1,200 3-foot tree boxwood in a Virginia nursery. Half of these plants had been propagated from cuttings, which were taken from a plant in one community, while the rest were from a different plant growing 35 miles from the first community. All were propagated at the same time. The sudden freeze had killed all of the plants from one parent, while those from the other were not harmed. The nurseryman said the two parent plants appeared outwardly to be alike.

Pests

Nematodes of several species are found in the soil on and about boxwood roots. Where the plants are given a fair chance, the nematodes will cause no damage whatever. However after the boxwood has been fumigated, sprayed, cultivated, mulched, etc., and these treatments have been followed by bad weather, it is customary to blame all of the losses that follow on the nematodes.

A group of dwarf and tree boxwood at West Point, Virginia, lost practically all of their leaves. A local professional worker sent specimens away for examination. The diagnosis was that the boxwood had been damaged by nematodes. When I visited the garden later, I discovered that the owner had applied a **dusting** of **wettable sulphur,** which had been sold to him as **dusting sulphur.**

The dusting operation was interrupted by a light shower of rain; and this made the foliage appear as if it had been sprayed with milk. Because of the shower, about 20 plants were not dusted. All were found in good condition. At later dates, I examined these plants twice. The nematodes had "damaged" only the 50 or so plants that had been burned with **wettable sulphur.**

Leaf miners are the most serious pest of tree or "American" boxwood. Fortunately, these insects may be controlled with modern chemicals. The adult form, a small midge, appears about mid-May in the New York City area and leaves may then be sprayed with Diazinon. Malathion in either dust or liquid form will kill the miners if applied at the proper time. Cygon or other systemic insecticides may be used alone or with other chemicals.

The miners spend most of the year inside the leaves and emerge in late April to early May, when they mate, deposit eggs in the leaf tissue and die. If one can be on hand when they are emerging, a thorough dusting with malathion will kill all of them. Otherwise, the liquid malathion is best.

Mites can be controlled by using Kelthane or other mixtures which contain the same active chemicals.

Psyllids cause the tender leaves to curl but really do not injure the boxwood. It is difficult to strike these insects with the material when the have the protection of the curled leaves. However, about the end of May or early June, when they run about in the plants, they may be killed with malathion.

Scale insects sometimes attack boxwood. Malathion will kill them in the crawling stage (just after hatching). A systemic insecticide, applied over the root area, and a malathion spray should control this pest.

For a more detailed discussion on the care of boxwood, see *The Boxwood at Stratford Hall,* published and copyrighted by the Robert E. Lee Memorial Foundation, Stratford, Virginia 22558. (75 pages, $4.95 postpaid.)

How to grow, how to use

HOLLIES IN EASTERN GARDENS

Robert B. Clark and Dorothy E. Hansell

A DOZEN or more species of evergreen holly are adapted to gardens of New England and the Middle Atlantic States east of the Appalachian Mountains. In western Pennsylvania, upper New York State and northern New England where the winter climate is harsher, only a few species may be grown and then only when provided with special care.

A condition which bears directly on successful holly culture and which every gardener is aware of, I am sure, is that hollies have their sexes separate on different plants. Some hollies bear berries, others do not. Less well understood is how to insure this much desired berry production. The gardener must have flowers of both sexes *in bloom at the same time* and conveniently nearby so bees may bring life-bearing pollen to fruit-bearing flowers.

As a guideline it is well to ascertain that a staminate (male) flowering holly with compatible pollen be in the neighborhood (no more than ½ mile or 3 or 4 city blocks distance), or that sprays of pollen-bearing flowers be brought at the right day(s) to the potential fruiting holly. The branch should stand in a container of water sunk in the ground beneath the tree. This bouquet should be inspected daily during the brief blooming period to insure its freshness. A person who wishes to produce high-quality crops of holly berries each year is well advised to plant a small holly of the same species for every dozen fruiting plants. If you want berries, insure pollination.

Hollies thrive in humid climates. During droughts syringe the foliage with a mist from the hose.

Planting and Transplanting

Hollies make most satisfactory growth in well-drained soils of moderate fertility. For gardens with heavy (clayey) soils which hold water too long, we suggest that the hollies be planted in raised beds of suitable soil using railroad ties or rocks for retainers. Skim off the top few inches of soil. Place the plants in the chosen position with the ties or rocks as a border. Fill the intervening spaces with the sandy loam soil which favors holly growth so well, tamping it to exclude air pockets.

Transplanting is best done in the spring before growth starts. The soil should be friable, easily worked, and not wet. The holes should be adequate in diameter, its depth equal to the height of the ball. As with all evergreens the plant is best handled when balled and burlaped. A liberal amount of leafmold is mixed with the backfill. A single watering should be sufficient for several days.

Water requirements are perhaps the most critical aspects of plant welfare. Test the soil by scratching its surface. If freshly exposed soil is darker than the surface then moisture is adequate. Wilting is another test for water need, but the careful gardener never permits this stage to come about. He may, however, bring it on by excessive watering—which can drown the plant, causing the leaves to droop.

A year or two after transplanting your holly, a handful or two of complete fertilizer (N-P-K: 5-10-5 or similar formulation) may be applied in the fall after growth has slowed. The best policy is to go slow with fertilizers on holly.

Hollies, like many other broadleaved evergreens, are shallow-rooted. Do not cultivate deeply around holly trees as this practice may destroy many of the feeding roots. Instead, apply a mulch of coarse organic material which retards soil evaporation.

Freshly dug hollies have been largely deprived of their small feeder roots, thus upsetting the balance between shoots and

roots. A readjustment can easily be made by pruning. Simply cut back the tips of many of the branches.

Pests

The most troublesome pest of American and English hollies is the leaf miner. This insect deposits its eggs beneath the upper surface of the leaf in the spring. The best time to spray is just as the adult flies emerge from the leaf but before they have begun to make punctures on the leaf surface. This season in the vicinity of New York City comes about mid-May. Spray as the new leaves open with Diazinon, later with Meta-Systox-R; or, use the systemic insecticide Cygon 2E. (See HANDBOOK ON GARDEN PESTS.)

Red mites sometimes appear on the lower surfaces of the convex-leaved Japanese holly's foliage. They are detected by the dull grayish appearance of the normally glossy leaves. For control use a miticide (according to label directions) at 10-day intervals through the hot summer, or apply a dormant oil spray in late March or early April before growth starts.

Evergreen Hollies

Evergreen hollies which are being grown in eastern gardens include the following red-berried holly trees: American (*Ilex opaca*), English (*I., aquifolium*), horned or Chinese (*I. cornuta*), *I. ciliospinosa*, birdlime or Nepal holly (*I. integra*) and tara (*I. latifolia*); also the following shrubs: soyogo (*I. pedunculosa*), Perny (*I. pernyi*), Yunnan (*I. yunnanensis*), tsuru (*I. rugosa*)—all with red berries; Japanese (*I. crenata*) and inkberry (*I. glabra*), which are black-fruited.

In planting American holly, prudence dictates that even small plants be spaced at a minimum of 20 feet apart for optimum branch development. Given favorable conditions, a tree should attain a height of 20-25 feet in a comparable number of years.

The American holly is capable of withstanding light or high shade. When you wish to plant a specimen tree take special care to visualize its eventual form.

English holly is discussed on page 29.

Perny holly, native to China, is a straggly shrub with leaves resembling the horned holly, but smaller. This species with English holly contributes to a group of handsome treelike hollies called *Ilex aquipernyi*.

Ilex ciliospinosa (no common name) is a handsome, narrow plant with small leaves. Scarlet berries are borne on twigs of the previous year.

Birdlime or Nepal holly is a native of Japan. The name alludes to a concoction made from the sap which has been used to discourage birds from perching. It is one of the very few smooth-margined or spineless hollies.

Soyogo holly of China and Japan is a small tree of very slow growth, although perfectly hardy in this country.

Shrubby hollies find favor with homeowners whose garden space is limited. Inkberry, if it were not native, would be more highly prized. The berries are not showy because they are black. 'Ivory Queen', however, has charming ivory-white berries.

A small-leaved upright shrub on the order of Japanese holly but with red berries is Yunnan holly from remote China. It is exceedingly hardy.

Hollies for Hedges

Screen or tall hedge

I. opaca
I. aquifolium (where adapted)
I. cornuta (where adapted)

Broad hedge of medium height

I. opaca 'Hedgeholly'
I. aquifolium (where adapted)
I. cornuta 'Rotunda'
I. crenata 'Microphylla'
I. glabra

Medium height, narrow width

I. pernyi
I. ciliospinosa

Low hedge

I. crenata 'Helleri'
I. crenata 'Green Island'
I. crenata 'Stokes'
I. cornuta 'Dwarf Burford'
I. rugosa

Marjorie J. Dietz

George Taloumis

The American holly (*Ilex opaca*) used in an informal rural setting (*above*) and in a more formal, elegant situation (*right*). Although culture, climate and corrective pruning can all contribute to the appearance of the tree, its natural shape, especially in full sun, is usually pyramidal.

Alice Dustan Kollar

Ilex 'San Jose' in bloom. Red berries from previous season are also evident.

SELECTED LIST OF HOLLIES FOR CERTAIN USES OR HAVING SPECIAL CHARACTERISTICS

For specimen plant	English holly *(Ilex aquifolium)* and its many cultivated varieties (cvs.); Chinese holly *(I. cornuta)* and *I. c.* 'Burfordii', American holly (*I. opaca*) and its many cvs., including 'David' (male), 'Farage', 'Jersey Knight' (male), 'Judge Brown', 'Merry Christmas', 'Miss Helen', 'Old Heavy Berry'
For hedge	English holly; Chinese holly 'Burfordii'; Japanese holly *(I. crenata)* many cvs; inkberry *(I. glabra)*; Perny holly *(I. pernyi)*; American holly 'Clark', 'David' (male), 'Hedgeholly'
Spreading habit	Japanese holly 'Convexa', 'Helleri', 'Mariesii', 'Repandens', 'Kingsville Green Cushion', 'Green Island': American holly 'Maryland Dwarf'
Dwarf habit	Japanese holly 'Helleri', 'Mariesii', 'Stokes', 'Kingsville Green Cushion', 'Green Island', 'Microphyllia'
Dense foliage	English holly—many cvs; Japanese holly—many cvs; American holly 'Clark', 'Cumberland', 'David' (male), 'Farage', 'Hedgeholly', 'Jersey Knight' (male), 'St. Mary'
Male flowers	All species. American holly 'David', 'Jersey Knight', 'Santa Claus'
Dark green foliage	English holly 'Wilsonii'; Japanese holly—many cvs; *Ilex integra;* American holly 'Far Age'
Glossy foliage	English holly 'James G. Esson'; Japanese holly 'Convexa'; American holly 'Cumberland', 'East Palatka', 'Jersey Knight', 'Judge Brown', 'Old Heavy Berry'
Small leaf	Japanese holly—many cvs; inkberry; narrow-leaved dahoon (*I. cassine angustifolia*); Perny holly; yaupon (*I. vomitoria*); Yunnan holly *(I. yunnanensis);* American holly 'David', 'Hedgeholly', 'St. Mary'
Large leaf	Lusterleaf holly (*I. latifolia*); *Ilex rotunda;* American holly 'Old Heavy Berry'
Curled leaf	English holly—some cvs; American holly 'David', 'Hedgeholly', 'Emily', 'St. Mary' (wavy)
Smooth (spineless) leaf	English holly—some cvs.
Clustered berries	English holly; dahoon; Chinese holly; inkberry; *Ilex rotunda;* yaupon; American holly 'Manig', 'Miss Helen'
Yellow berries	American holly *I. opaca xanthocarpa* 'Boyce Thompson'

ENGLISH HOLLY

How to grow this choice broad-leaved evergreen— told by one who does it

Kathleen K. Meserve

ENGLISH HOLLY *(Ilex aquifolium)* has featured in the religious rites and superstitions of various sections throughout Europe since the time of Zoroaster; today it ranks as an outstanding ornamental. In the United States, English holly found a moderate climate to its liking in the Pacific Northwest. Indeed, so suitable to its growth is this area that the holly has seeded itself and become naturalized. The same is not true of the eastern part of the country. The extreme summer heat in the southern states and the severe winter cold in the North, limits the areas in which English holly can be grown.

In well protected locations, English holly can be found as far south as the coastal sections of Georgia and as far north as Cape Cod, Massachusetts. It seems to do best along the coast of Virginia, Maryland, Delaware, New Jersey, and Long Island, and in the Pacific Northwest. On Long Island, however, it is interesting to note that we have not found an English holly which antedates 1903.

Hardiness

The rather limited range of English holly in the eastern United States has given rise to the idea that it is not hardy. This notion may be faise and is probably based on the performance of a few tender strains of English holly. Evidence is being gathered which indicates that the English holly has a far wider range of hardiness than has been heretofore suspected in this country. Through breeding and selection from seedlings of hardy stock, hardier hollies can be developed, as evidenced by established trees growing in such severe climates as those at Buffalo and Syracuse in New York, at Lenox, Massachusetts, and in the Adirondack Mountains. Further encouraging evidence of hardiness is found in the holly imported from the mountains above the town of Sarajevo, Yugoslavia, to the Missouri Botanical Garden, where it has been growing more successfully than many varieties of the supposedly more hardy American holly (*I. opaca*).

In our experience of growing several thousand English holly seedlings, we have found great differences in hardiness between seedlings from different trees. We have also found that hollies selected in the more moderate climate of the West Coast do not always adjust to our climate as well as some of the varieties growing in the East. Of particular interest is a group of holly seedlings grown from an English hybrid which was on the Eldridge Estate in Great Neck, Long Island. The original Eldridge tree has been propagated and distributed under the erroneous name of *altaclarensis*. Among the many seedlings from that tree, which have been distributed among institutions, nurseries, and private gardens, there are several well worth mentioning for both their hardiness and beauty. One, in particular, has attracted attention and has been selected and named 'James G. Esson' (in spite of the fact that it is female). This is only one example of a holly that may extend the English holly's growth area.

Where low winter temperatures are the limiting factor, more resistant strains may yet be found among the English hollies, and especially among hybrids between English holly and a closely related species from the Canary Islands. For areas where summer heat is great, English holly may also offer selections more resistant to burning than any we now know; but a more likely answer to the holly question for such climates at present seems to be Chinese holly (*I. cornuta*). This species, native to China, is beautiful and variable, and as yet but little explored. To date we know that it will stand summers where the temperatures rise to 109° to 118° F.

George Taloumis

A form of English holly (*Ilex aquifolium*) with rather small, variegated leaves.

Experimenting with Holly

Advancing the holly frontier lies largely in the hands of the home gardener who is willing to do a little experimenting. One experience means nothing; many experiences tell a story. However the gardener may approach this experiment, whether by growing a few holly varieties, or growing seed obtained from particularly cold or hot sections of the world, or by crossing one species with another, his efforts will contribute to the little knowledge which we have. Even failures may help—sometimes they are forgotten but they can be as important to the whole story as the successes. Only in this way will more useful, more beautiful, and hardier hollies be found to enrich our winter gardens in temperate or cold climates.

In order to go ahead with experiments, the gardener must learn what he can about holly. Perhaps some of our experiences will be helpful to others.

Our "laboratory" has been our plantings of thousands of English hollies. We have planted blocks of seedlings in different exposures, we have planted the same variety in different exposures, and we have studied the plants through all seasons. There are so many characteristics to consider and there is so much variation between individual plants, it would be difficult for the human mind to catalogue them all. We have found, however, certain basic facts about holly's culture here on the North Shore of Long Island which we believe may be useful elsewhere.

When to Plant

Spring is the ideal planting time for English holly. Although the recent winters have been mild, there is always the possibility that the next one will be a good old-fashioned "freezer." In that case, the holly with its roots below the frost level is the holly which will come through best.

Transplanting holly should be done as soon as buds begin to swell in the spring and not later than the first of May. If transplanting is done early, the holly will then grow new roots in its new location. These roots will be needed through the drought and hot summer to follow.

Potted hollies or those which have been grown in the house after the Christmas season are best put outside after the danger of late frost is over but before the weather becomes too hot. Any soft, new growth should have a slight protection from the sun for about a week or until it hardens.

Where to Plant

In choosing a location, consider your holly. A hardy variety can be put in full sun and wind. All hollies, however, will remain more handsome if the foliage is protected from the winter sun and given full summer sun. This can be done by properly placing the plants on the north side of tall evergreens or buildings. If the distance from the shelter is just right, the plants will receive sun in the summer, when the sun is high and shadows are short, but will be in the shade in winter when the sun is low (see diagram). Air circulation is important. A location on the lawn is better than one against the house. We have found that winter sun

The Conard-Pyle Co.

Plants of *Ilex* x *meserveae* 'Blue Princess', a recent holly introduction from Kathleen Meserve. It has purple-blue stems, abundant foliage and glossy bright red berries. Previous Meserve introductions include 'Blue Boy', 'Blue Girl' (both patented), and 'Blue Angel'.

reflected from a white house back on the holly can be most damaging, particularly if the holly is sheltered from the wind. Protecting a holly by cover such as burlap in the winter is not desirable. A variety or species which must be covered during the months when it is at its prime and its beauty most wanted should not be grown.

High shade or sun filtered through deciduous trees is often recommended. We do not agree. Any shade during the summer limits the potential strength of the holly. Any sun during the winter and particularly during late February and March is a hardship. Under deciduous trees the holly gets shade in summer, sun in winter, just the reverse of what can be called protection.

When planting, we recommend pouring very wet peatmoss in the bottom of the hole and setting the holly on top. Roots will rapidly grow down through this and the tree can better resist the heat of the summer and cold in the winter to come.

Sandy soil is ideal. Where soil is heavy, plant on a slope but never where puddles form after a rain.

Watering

A newly planted holly may need watering during the first two or three summers but do not encourage late growth by watering after the first of September. By Thanksgiving, however, if the ground is dry, a good watering is in order—this late in the season, new growth will not start.

Fertilizing

Feed holly after winter sets in. We prefer December or January and use a slow, organic fertilizer. The colder the climate, i.e., the shorter the summer, the less fertilizer. Late spring or summer feeding, like late watering, encourages growth late into the fall, and the tender new branches are often winter-killed. Slight winter-burning which is liable to occur on small plants is not serious, but if the winter-killed shoots are numerous, the above-ground parts of the plant will be small in relation to its roots. Once this condition starts, winter-killing will tend to increase each year. Should this situation arise, we recommend transplanting the holly or giving it a good root-pruning in the spring.

Remember this same balance when pruning a small plant, and trim it but lightly, and in the spring. As it grows, however, more can be cut each year until finally you can deck your halls with boughs from your own holly tree at Christmas time. Remember, English holly, like American, has both male and female trees. It is necessary to have both if berries are expected.

50 BROAD-LEAVED EVERGREENS FOR THE PACIFIC NORTHWEST

Excluding rhododendrons and camellias

Brian O. Mulligan

HERE are fifty broad-leaved evergreen plants, ranging in size from trees to ground covers, which can be grown in the climate of the Puget Sound region from Victoria, B. C., southwards down the coastal strip west of the Cascade range.

They comprise five trees, forty-one shrubs (of which fifteen are large, commonly reaching 12 feet or more in height) and seven ground-cover plants; three of the latter are common also to the shrub list, namely, *Daphne cneorum*, *Euonymus fortunei* in certain forms, and *Hedera helix*.

It is most difficult to select fifty for this region, where the choice is so wide, and many excellent plants have perforce been omitted for various reasons, including camellias and rhododendrons which are dealt with elsewhere in this issue.

Such factors as hardiness, eventual size, garden value, and availability have all been taken into consideration in drawing up the list, for the benefit of those who have the good fortune to make gardens in this climatic zone. Native western plants are marked with an asterisk (*).

Strawberry Tree *(Arbutus unedo)*. Growing to 12 to 20 feet. Bushy shrub or small tree. Flowers and fruit in November and December. Flowers small, white, urn-shaped, in pendulous clusters; fruit red, ¾ inch in diameter, insipid. Decorative in early winter. Damaged in severe winters but usually recovers.

*__Hairy Manzanita__ *(Arctostaphylos columbiana)*. Compact shrub 5 to 8 feet tall, stems hairy. Leaves oval, gray-green; flowers white or pale pink, in clusters, April to May; fruit light brown, September to October. Hard to transplant except when small.

*__Common Manzanita__ *(A. manzanita)*. Shrub or tree growing 8 to 10 feet. Leaves green, larger and thicker than those of *A. columbiana*, stems and branches red-brown, smooth. Flowers pale pink, in drooping clusters, February to March; fruit redbrown. *A. patula* is similar but more compact and probably hardier, extending into Siskiyou Mountains of southern Oregon.

*__Bearberry Kinnikinnick__ (*A. uva-ursi*). See page 4.

Darwin Barberry *(Berberis darwinii)*. Shrub 8 to 10 feet high. Leaves small, holly-like, spiny. Flowers orange, in pendulous racemes, April. Berries purple, August to September, taken by birds. Excellent hedge plant. Propagated by seeds, or cuttings in late summer.

Rosemary Barberry (*B.* x *stenophylla*). Large shrub to 10 feet high and greater width. Leaves short and very narrow. spine-tipped. Produces quantities of small golden flowers on long arching branches in April. Berries small, purple-black. Many excellent seedling forms, such as *irwinii, coccinea,* and *compacta,* usually smaller in size.

Threespine Barberry *(B. triacanthophora)*. See page 5.

*__Tree-anemone__ (*Carpenteria californica*). Forms a densely branched shrub 6 to 8 feet tall, but larger in wild state (Fresno Co., Calif.). Resembles an evergreen mock-orange *(Philadelphus)*, producing a succession of pure white flowers in June, each 2½ inches across, slightly lemon-scented. Needs a dry and sunny location.

*__Point Reyes Ceanothus__ *(Ceanothus gloriosus)*. Vigorous ground cover, 12 to 15 inches high. Leaves thick, elliptical, dark green, toothed. Flowers dark blue to purple, in stalkless clusters, sparsely produced in Seattle.

Brian O. Mulligan

E. F. Marten

The white lemon-scented flowers of tree-anemone (*Carpenteria californica*) (*above*) are 2½ inches in diameter. The effect of the shrub is that of a mock-orange (*Philadelphus*) with evergreen foliage. The laurel-leaf rock-rose (*right*) has leathery foliage and white flowers, 2½ inches across.

George Taloumis

Foliage of the cherry-laurel (*Prunus lauro-cerasus*). Some forms have smaller leaves.

*__Snowbrush, Mountain-balm__ *(C. velutinus)*. Vigorous shrub growing to 15 feet. Leaves large, oval, sticky and fragrant. Flowers white, in conspicuous clusters, May. Excellent for sunny, dry banks, but difficult to transplant. Should be grown from seeds. Very hardy.

Mexican-orange *(Choisya ternata)*. Shrub 7 to 8 feet high. Leaves glossy green, trifoliate, aromatic. Flowers in clusters at ends of stems, white, 5-petalled, 1 inch wide, fragrant, in May. Should have a warm corner. Sometimes damaged in winters but seldom killed.

Laurel-leaf Rock-rose *(Cistus laurifolius)*. Robust upright shrub, 7 to 8 feet tall, long-lived in sunny well-drained site. Leaves dark green above, paler beneath, leathery. Flowers in loose panicles, white, 2½ inches across, June-July.

Cotoneaster lactea. Shrub growing to 10 feet; branches spreading and arching. Leaves markedly veined, grey beneath. Flowers white, in clusters along branches; berries small, bright red, November to January. Very decorative in midwinter.

Rockspray Cotoneaster *(C. microphylla* and varieties). Small shrubs, usually 1½ to 3 feet tall. Leaves very small, dark green, shining. Flowers usually borne singly but very freely, white, May to June. Berries, red, September to October. Suitable for rock gardens.

Willowleaf Cotoneaster *(C. salicifolia)*. Tall, vigorous shrubs to 15 feet. Leaves narrow, conspicuously veined, usually wooly beneath. Flowers white, June, in compact clusters. Berries bright red, October. Can be trained on walls or fences.

Garland Flower *(Daphne cneorum)*. See page 6.

Winter Daphne *(D. odora)*. Shrub about 4 feet high. Leaves 3 to 4 inches long; flowers purple (or white), in compact small heads, very fragrant, April. Needs warm corner.

Thorny Elaeagnus *(Elaeagnus pungens* 'Maculatus'). See page 6.

Eucryphia nymansensis. Vigorous natural hybrid between Chilean *E. glutinosa* (deciduous) and *E. cordifolia* (evergreen) found in an English garden. Erect dense tree to 40 feet tall. Compound leaves. Flowers white, fragrant, 4-petalled, saucer-shaped, 2½ inches wide, August. Not too hardy when young but worth care and protection.

Winter Creeper *(Euonymous fortunei)*. See page 6.

*__Silk Tassel__ (*Garrya elliptica*). Upright shrub, usually 8 to 10 feet tall. Leaves dark green above, grey and woolly beneath, wavy on margin. Flowers in pendent tassels, 4 to 6 inches long, grey-green, January to February; male plants more ornamental than female. Needs a sunny bank; difficult to transplant except from pots.

Miquel Wintergreen *(Gaultheria miqueliana)*. Ground cover, 9 inches high, spreading by underground stems. Leaves thick, dark green. Flowers white, globular, in racemes, May. Fruit pure white, size of a pea, September to October. One of the hardiest Asiatic species.

Brian O. Mulligan

The pea-sized white fruits of Miquel wintergreen (*Gaultheria miqueliana*), a ground cover.

***Salal** *(G. shallon).* Shrub 3 to 5 feet tall. Leaves about 3 inches long, shining on upper surface. Flowers in racemes, 3 to 5 inches long, small, urn-shaped, white or pinkish, May. Fruit black, globular, sweet and edible. Prefers semi-shade; spreads by underground stems.

English Ivy *(Hedera helix* varieties). See page 7.

English Holly *(Ilex aquifolium* varieties). See pages 7 and 29.

Camellia-leaved Holly *(I. altaclarensis* 'Camelliaefolia'). One of the best of the hybrid hollies, with broad, glossy, dark green, almost spineless leaves. Berries large, bright red, but not freely produced on small trees. Grows 25 to 30 feet.

Japanese Holly (*I. crenata* 'Convexa'). See page 7.

Long-stalk Holly *(I. pedunculosa).* Large shrub or small tree to 30 feet. Leaves spineless, oval, shining; fruit on long slender stalks, bright red, slightly smaller than English holly. Hardy and ornamental, but both sexes required for fruiting.

Mountain-laurel (*Kalmia latifolia*). See page 9.

Drooping Leucothoë *(Leucothoë fontanesiana)*. See page 10.

Japanese Privet *(Ligustrum japonicum).* Bushy shrub, usually 5 to 7 feet tall. Leaves rather thick, dark green, shining. Flowers in pyramidal clusters, white, July to August. Makes a dense hedge. Variety 'Rotundifolium' is slow growing, very compact, with rounded leaves.

Southern Magnolia *(Magnolia grandiflora).* Tree growing to 80 feet. The familiar evergreen magnolia with glossy leaves, flowering in summer. Flowers very large, white, fragrant, cup-shaped. Requires a warm corner or wall to flower freely. Varieties 'Exmouth' *(lanceolata) (exoniensis),* 'Goliath', and 'St. Mary' are superior forms.

***Oregon Holly-grape** *(Mahonia aquifolium)*. See page 10.

***Cascade Mahonia** *(M. nervosa).* Groundcover shrub for shady places, 1 to 2 feet tall. Leaves of 9 to 17 leaflets, tough, elongated, and sharply pointed. Flowers in long upright racemes, yellow, May. Fruit purple, August. Less easy to establish, but valuable.

Holly Osmanthus *(Osmanthus heterophyllus)*. See page 10.

Osmarea x burkwoodii. A valuable artificial hybrid between *Osmanthus delavayi* and *Phillyrea decora.* Forms a

Don Normark

Evergreen foliage and flowers of Chinese photinia (*Photinia serrulata*).

George Taloumis

Japanese privet (*Ligustrum japonicum*) is adaptable to topiary and special training.

dense bush 8 to 10 feet tall, with small toothed leaves. Clusters of fragrant white flowers in April. Excellent for hedges.

*__Oregon-boxwood__ (*Pachistima myrsinites*). Low, spreading shrub of 2 to 3 feet, somewhat variable in form, leaf size and shape. Usually found on dry slopes under partial shade. Leaves small, more or less oblong, slightly toothed. Flowers and fruit insignificant. Hardier than common box.

Chilean Pernettya (*Pernettya mucronata*). Shrub growing to 3 feet. Leaves small, shining, spiny-pointed. Flowers, small, white, bell-shaped, very freely produced, in May. Berries varying from white to red to purple, up to ½ inch wide. For berry production, two strains or varieties are needed.

Fraser Photinia (*Photinia* x *fraseri*). Natural hybrid between Chinese (*P. serrulata*) and Japanese (*P. glabra*) species. Vigorous, open branching shrub, 10 to 12 feet in height. Young shoots brilliant red in spring and summer. Prune annually in spring for best effect.

Japanese Pieris (*Pieris japonica*). See page 11.

Cherry-laurel (*Prunus laurocerasus*). Large shrub or spreading small tree to 25 feet. Various forms from different areas vary in habit, size, shape and color of foliage, and hardiness. Type used for hedges, but not satisfactory unless carefully tended. Forms from Balkans with small leaves are hardiest (varieties 'Schipkaensis' and 'Zabeliana'). Flowers white, in racemes 3 to 5 inches long in summer; fruit black. The Portugal-laurel, *P. lusitanica,* is somewhat hardier, with darker foliage, and grows equally large.

Laland Firethorn (*Pyracantha coccinea* 'Lalandei'). See page 11.

Sweet-box (*Sarcococca confusa*). Compact, dense shrub, 3 to 4 feet tall. Leaves oval, long-pointed, shining on upper side. Flowers small, white, fragrant, February to March. Fruit black, December to February. Shade-loving and will grow well on heavy soils. Valuable also for early, fragrant flowers. Frequently misnamed *S. ruscifolia,* which has red fruits.

Reeves Skimmia (*Skimmia reevesiana*). Low, spreading shrub, 1½ to 2 feet tall. Leaves narrow, long-pointed, dark green on upper side. Flowers in short clusters, white, fragrant, in May. Fruit dark red, oval or pear-shaped, October to April. 'Foremanii' and variety 'Rogersii' are

Whitie Marten

Flowering branch of the California-bay or Oregon-myrtle (*Umbellularia californica*).

George Taloumis

Reeves skimmia (*Skimmia reevesiana*) has narrow leaves. It grows about 2 feet tall.

hybrids with *S. japonica* and preferred to it for garden use.

Chinese Stranvaesia *(Stranvaesia davidiana).* Tall shrub, 15 to 20 feet high. Leaves narrowly oblong, 3 to 4 inches long. Flowers in compound heads, small, white with red anthers, June. Fruit round, ¼ inch wide, red, October to November. Variety *undulata* is much lower and more spreading in habit with smaller leaves, wavy along the margin.

***California-bay** or **-laurel; Oregon-myrtle** *(Umbellularia californica).* Tree 50 to 60 feet tall in the wild, smaller in cultivation in Northwest. Leaves oblong, 3 to 4 inches long, glossy above, strongly aromatic when crushed. Flowers small, creamy-yellow, in leaf axils, March to April. Fruit rounded, 1 inch long, plum-like, green becoming purple. Similar in appearance to bay tree (*Laurus nobilis*) but much hardier here.

***Evergreen Huckleberry** *(Vaccinium ovatum).* Shrub 6 to 8 feet high. Young shoots purplish. Leaves small, ovate, thick, glossy on upper surface. Flowers in short clusters, small, bell-shaped, pink, May. Fruit globose, black or glaucous, edible, October. Attractive at all seasons. Likes partial shade.

Cowberry, Mountain Cranberry *(Vaccinium vitis-idaea).* Widespread native in mountains of northern hemisphere. An admirable ground-cover in neutral to acid soils, growing 9 to 12 inches high. Flowers in clusters in summer, bell-shaped, white or pale pink. Fruits edible, tart. Subspecies *minus* smaller in all parts than type; from N. America.

David Viburnum *(Viburnum davidii).* Low, compact shrub, 3 to 4 feet high. Leaves 4 to 5 inches long, three-veined, dark green on upper surface. Flowers very small, densely crowded in heads, white, June; male and female on different plants. Fruit (on latter) small, oval, steel-blue, September to October. Especially valuable for fruit if both sexes are planted.

Laurestinus *(V. tinus).* Dense, more or less upright shrub, 7 to 10 feet tall. Leaves oval, 2 to 4 inches long, dark green on upper surface (shining in variety *lucidum*). Flowers small, white, in compact heads, 3 to 4 inches wide, December to April, according to variety and climate. Fruit very small, dark blue, seldom produced in quantity. Stands city conditions well.

HYBRID RHODODENDRONS FOR THE PACIFIC NORTHWEST

. . . and similar climates elsewhere

J. Harold Clarke

RHODODENDRONS are standard plant material for gardens in the Northwest. The number of named varieties commonly available in the trade exceeds one hundred, with three or four times that many appearing in collectors' gardens. In addition about four hundred species of rhododendrons are being grown by fanciers in the Northwest.

Usually the gardener starts with one or two of the more common, standard named varieties, goes on to less common varieties, then, if he becomes really interested in this group of plants, to the dwarfs, and finally to the species. It might be expected that one would go from the common wild types (species) to the more highly refined and selected horticultural varieties. Actually, the horticultural varieties have been available in this country a longer time than many of the species which have been brought in from Asia only within the last few years. Since the species are preferred mostly by the more avid rhododendron growers, this discussion will be limited to the cultivated horticultural varieties.

A Favorable Climate

My remarks apply particularly to that part of the Pacific Northwest from the Canadian border south to the California border and west of the Cascades. Of course, rhododendrons are grown north and south of these limits, but in general the western portion of Oregon and Washington does constitute a rather unique plant growing region. This area is quite variable as to topography and climate and, of course, there are many local areas where the soil is too rocky, or the elevation too high, or the slope too steep, or the drainage too poor for optimum rhododendron growth.

Brian O. Mulligan

Rhododendron 'Unique' is a favorite in the Pacific Northwest. Its flowers are creamy white or buff.

The climate is generally mild, temperatures usually going not much below 10° F. Rainfall is heavy during the winter. Summer temperatures near the coast are usually in the sixties or low seventies, while inland they are reasonably high although not very often above 90° F. Summer rainfall throughout the entire area is rather low and irrigation is necessary or desirable.

Suggestions as to varieties will be based chiefly on the landscape uses to which the plants may be put. Rhododendron flowers will usually be in good condition for 2 or 3 weeks on any one variety and the blooming season may extend from early February to the first of July if one has a fairly large collection. Furthermore, the foliage of many rhododendrons is very satisfactory in landscaping. It is evergreen (in the varieties discussed here) and offers a range in size, color, texture, and seasonal coloration.

For descriptions of varieties readers are referred to Rhododendron Information, published by the American Rhododendron Society, where about 400 varieties are described and given ratings as to general garden quality and hardiness.

Varieties Grouped As To Size

In grouping rhododendrons let us first consider the tall ones which might be used as specimen plants, growing by themselves, uncrowded so they may develop flowering branches from the ground to the top and produce symmetrical shrubs as wide as they are high, or perhaps wider. Varieties which may be leggy, but which have beautiful flowers and perhaps attractive growth in the top, may be used as background material for lower-growing rhododendrons, or other shrubs.

Lists such as this reflect personal taste and experience. The following varieties, which I would like to suggest in the tall group, might be expected to reach a height of 7 or 8 feet in ten years.

'A. Bedford'—lavender, dark eye
'Anna Rose Whitney'—rose pink
'Beauty of Littleworth'—white
'Cynthia'—rosy crimson
'Faggeter's Favorite'—silvery pink
'Mrs. Charles Pearson'—pale blush pink
'Mrs. E. C. Stirling'—blush pink
'Mrs. Lindsay Smith'—white
'Mrs. T. H. Lowinsky'—opens blush, soon with reddish brown blotch
'Pink Pearl'—rose pink fading blush

There are many rhododendrons of medium size, reaching a height of 5 or 6 feet in ten years, which would be used a little differently than the tall varieties. They could be used in the shrub border, neither too far to the back nor too close to the front, or in base plantings if it is realized that they may reach a height of 10 or 12 feet in the course of twenty years. The following varieties are suggested in this group:

'Antoon Van Welie'—carmine pink
'Autumn Gold'—salmon apricot
'Betty Wormald'—pale pink center, pale purple blotch
'Carita'—primrose yellow
'Dame Nellie Melba'—pink
'David'—blood red
'Doctor Stocker'—ivory white
'Fastuosum Flore Pleno'—lavender blue
'Gomer Waterer'—blush white
'Hyperion'—blush white, purple spot
'John Coutts'—salmon pink
'Loder's White'—pale mauve edge fading to white
'Lord Roberts'—dull red, black blotch
'Marinus Koster'—pink, brown spots
'Mother of Pearl'—blush, turning snow white
'Mrs. G. W. Leak'—pink with brown-purple blotch
'Radium'—geranium red
'Van Nes Sensation'—pale lilac
'Vulcan'—bright red
'White Swan'—pure white

In this general size class there are also several hybrids of the species *R. griersonianum,* which are brilliant in flower color, surely a little more tender to cold and possibly less attractive in foliage. In this group I would suggest:

Rhododendron 'Blue Peter' has lavender-blue flowers marked with a deeper blotch. This is a hardy variety which does well in the major rhododendron-growing regions of the country.

Marjorie J. Dietz

'Azor'—soft salmon
'F. C. Puddle'—orange red
'Fusilier'—scarlet
'Sarita Loder'—pale salmon pink
'Sunrise'—carmine lilac
'Tally-ho'—bright scarlet

Then there are other rhododendrons which will reach 3 or 4 feet in a ten-year period. We do not call them dwarfs, although they are low growing and especially useful in the border:

'Betty Arrington'—pink
'Blue Ensign'—pale lavender blue
'Blue Peter'—pale lavender blue, deep blotch
'Boule de Neige'—white
'Corona'—coral pink
'Grierosplendour'—red purple
'Jean Marie de Montague'—scarlet
'Lady Clementine Mitford'—peach pink, deeper margin
'Mahmoud'—pink, yellow blotch
'May Day'—scarlet
'Medusa'—buff orange
'Mons. Guillemot'—dark rose
'Mrs. Furnival'—light pink, sienna blotch
'Mrs. Mary Ashley'—salmon pink, shaded cream
'Mrs. P. D. Williams'—ivory white, brown spot
'P. J. M.'—lavender blue
'Purple Splendour'—deep purple, black spot
'Unique'—flesh, changing to buff

Among the dwarfs, which would reach 3 feet or less in ten years, there is a great deal of variation as to season, foliage, and type of growth as well as flowers. Some of these varieties will eventually go considerably above 3 feet and others will never reach that height. Suggested in this group are:

'Augfast'—blue
'Blue Diamond'—blue
'Bow Bells'—pink
'Cilpinese'—pinkish white
'Dora Amateis'—white
'Elizabeth'—light blood red
'Hummingbird'—pink, shaded vermilion
'Moonstone'—cream, edged pink
'Nereid'—orange pink
'Praecox'—rosy lilac
'Ramapo'—violet pink
'Sapphire'—blue
'Scarlet Wonder'—scarlet
'Temple Belle'—pale rose

Plants May Be Moved

The selecting of a small group of rhododendrons from the above lists for use in a particular garden will involve a good deal of study if one is new in this

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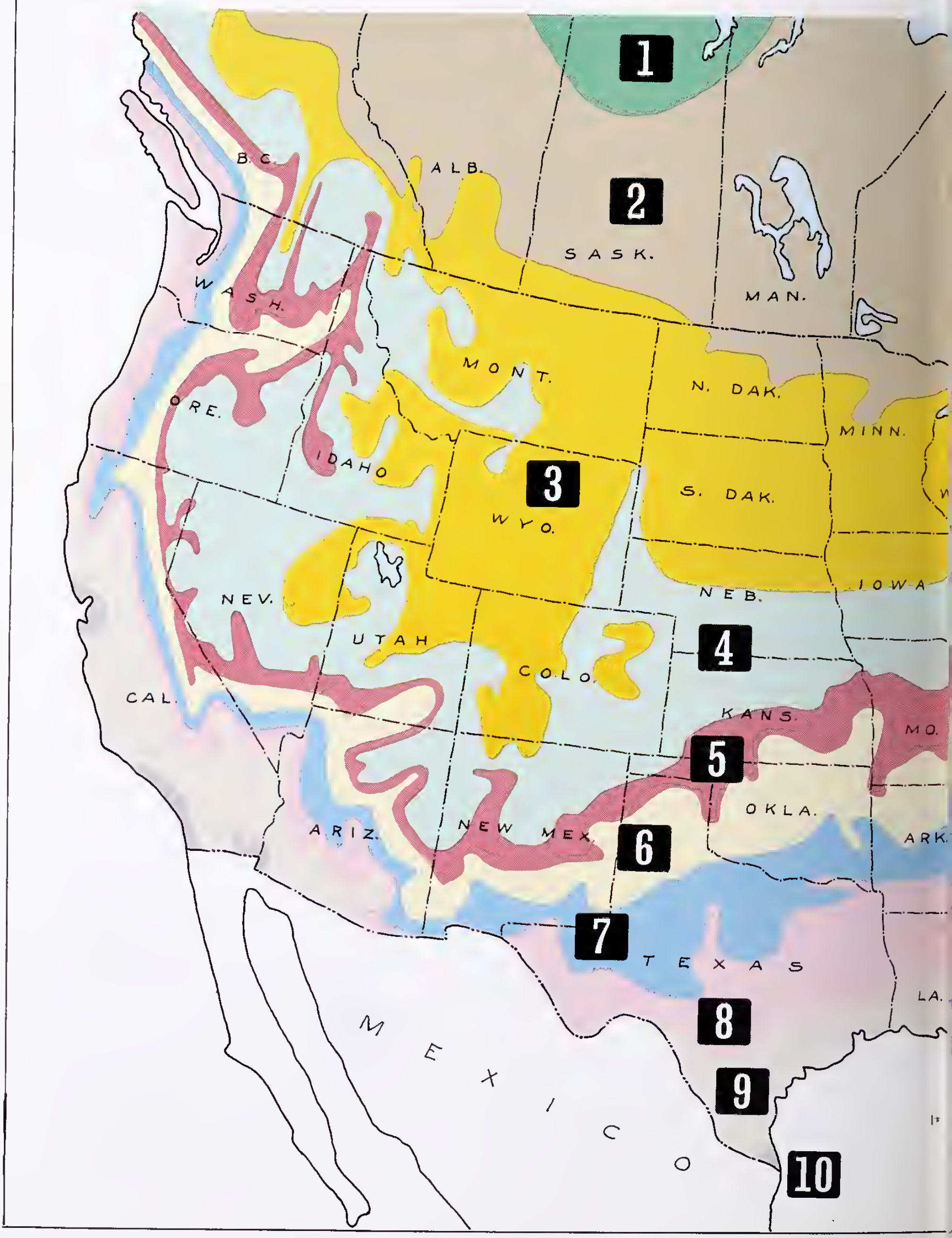

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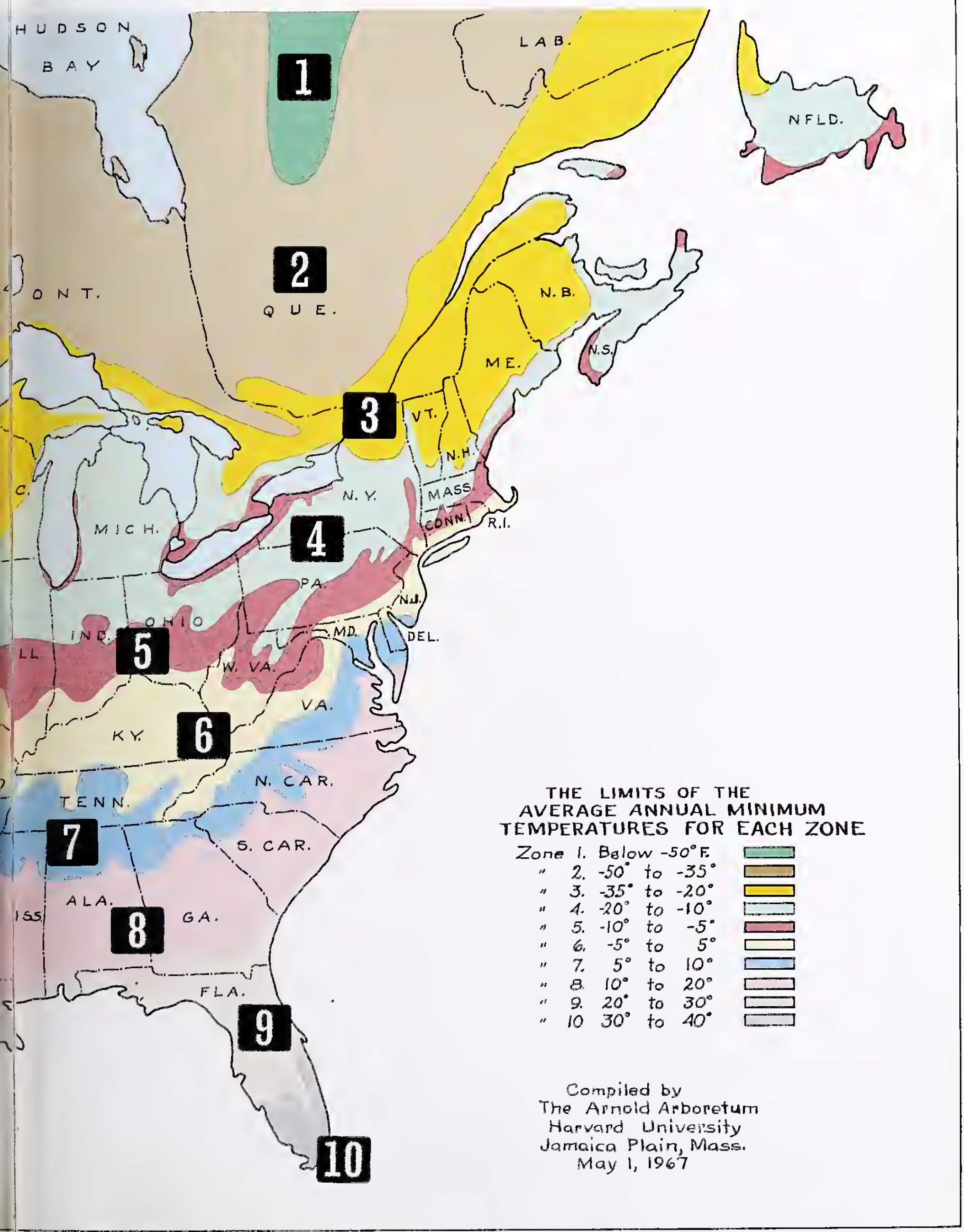

field. These plants will live a long time and give a great deal of pleasure if properly cared for, and if they are properly selected and located in the beginning. Rhododendrons have a very fibrous root system and lend themselves quite readily to being moved with a ball of soil. Many fanciers set their plants rather close together with the idea that they can spread them out later or move them to some other locations. Actually, rhododendrons are often dug, balled and burlaped, taken to flower shows, and then planted back in the garden with very little ill effect on the plants. This ease of transplanting permits a great deal of flexibility in the use of these plants in the landscape plan.

Soil

In the Pacific Northwest it is probably safe to say that any reasonably good soil where a lawn and a garden can be grown will be satisfactory for rhododendrons. They require good drainage and a good supply of moisture during the summer. Mulch, such as sawdust, is very desirable as it permits planting on a soil that is well drained and perhaps otherwise would dry out too much during the summer. *Rhododendrons are very shallow rooted and any cultivation which involves stirring the soil an inch or more deep would cause damage to the roots.* Where a sawdust mulch is used, a portion of the root system will usually develop in the sawdust above the soil. Much has been written about the use of well rotted sawdust but personal experience indicates that fresh sawdust is quite satisfactory. The thing to remember is that, as decay organisms begin to break down the sawdust mulch, nitrogen will be deficient and the plants may become quite yellow. This can be offset by applying a nitrogen fertilizer, at least twice as much as would be used on the same soil for plants under ordinary cultivation. The plants are the indicators, and will tell whether they need nitrogen or not and whether you have satisfied their needs after you supply an extra amount.

The general level of fertility to maintain, especially with respect to phosphorous, potassium, and other elements aside from nitrogen, will depend on the natural fertility of the soil. One should think not of a special rhododendron fertilizer program so much as a program for the particular soil in the garden. Rhododendrons do have one requirement which is different from many other plants: they prefer (and most require) an acid soil. However, most of the soils in the area discussed here are acid enough, especially in the regions where rainfall is high. In some of the marginal areas where the rainfall is relatively low there may be soils which are too alkaline for optimum growth. On such soils, it is usually satisfactory to use ammonium sulfate as a source of nitrogen as it will gradually cause the soil to become more acid. In very alkaline soils, of course, it may be necessary to use sulfur to acidify the soil. In such cases local advice from the county agent or other experienced people should be sought. Apparently, alkaline soils are unfavorable to certain plants partly because they prevent such plants from taking in sufficient iron, which is one of the minor elements essential to plant growth. There are now available certain forms of iron known as chelates, which will remain available to the plant even though the soil is alkaline. If in a rather alkaline soil rhododendrons are yellowish and do not respond to fairly heavy applications of nitrogen, try correcting this condition by the use of chelated iron.

Pests Affecting Rhododendrons

One of the most serious rhododendron pests in the Northwest is the strawberry weevil and two or three related weevils, which may girdle young plants or even older ones. Fortunately, some of these can be controlled by chlordane. Some pests which are prevalent in the East and South, such as lace bug, are much less serious in the cooler regions of the Northwest. Slugs do occasionally cause damage, especially to younger plants, but

Marjorie J. Dietz

Rhododendron 'Boule de Neige' is a white-flowered favorite as popular in the East as in the Northwest. Young plants grow slowly at first, remaining rounded and compact, but after ten years or so the plants begin to stretch upward and outward, reaching 5-6 feet.

metaldehyde baits or dusts are quite effective against them.

Because of the relatively high humidity in the Northwest, certain diseases such as the leaf spots and cane blights may be more frequently met with than in drier regions. In most cases, keeping the plants in a vigorous growing condition, plus some pruning out of diseased twigs or branches if they do appear, will be sufficient. Occasionally it may be desirable to spray with a weak bordeaux mixture or with one of the newer fungicides such as benlate. Root rot diseases may occasionally cause trouble in poorly drained, heavy soils. Some varieties are more resistant than others but improving drainage, of course, is the primary factor in controlling this. Some of the new soil sterilants (see HANDBOOK ON SOILS, page 51) might be considered under very special conditions. As a general rule, rhododendrons are no more likely to be bothered by insect and disease pests than are other shrubs and in many cases have proven remarkably resistant to injuries of this type.

Effect of the Freeze

After the very disastrous freeze of December, 1972, it is difficult to discuss rhododendrons in the Northwest without bringing up the matter of injury during that period. It is the considered opinion of most rhododendron growers with whom I have talked that the experience of that freeze should not seriously affect the choice of varieties. It was the worst experience in some 100 years and many common trees which were considered completely hardy in this area were damaged or killed. It would seem reasonable not to avoid a variety which was injured at that time, when native trees, which have grown in the area from time immemorial, were also injured. It is true that certain varieties did come through with very little injury even under such unusual conditions. If one is planting rhododendrons where early fall and late spring frosts are very likely to be serious, then it would be desirable to select those varieties which have shown extreme resistance to such conditions.

Suggestions based on experiences in the Pacific Northwest

LANDSCAPE USES OF BROAD-LEAVED EVERGREENS

Otto E. Holmdahl

IN our mild and moist climate that grows nearly everything lavishly and seemingly effortlessly, together with a natural scenery as beautiful and diversified as any in the world, it is not surprising that we favor an informal, naturalistic style in our landscape design and gardens. We do our plantings in such a way that the trees and shrubs are allowed to develop as they do in nature, and our plant material, not the gardener's pruning shears, controls the design in the vertical plane.

All through the gardens in the residential parts of our cities and towns are to be found large trees of madrona, dogwood, maple, and oak, not to mention the cedars, hemlocks, and firs that were already here and were carefully preserved when the subdivisions were laid out. And just beyond are large tracts of land in the natural state.

Our soils are predominantly acid and so are just right for many evergreen and deciduous shrubs and trees and, of course, especially so for ericaceous (heath family) plants.

Rhododendrons

Of all the broad-leaved evergreens the rhododendrons are, no doubt, the most important, partly because of the tremendous number of species and hybrids and partly because of the differences in their form, size, and general appearance. As there are rhododendrons of nearly every color of the rainbow it is no wonder that we use them profusely in our gardens.

Other broad-leaved evergreens are planted in places where rhododendrons do not thrive—in windy, exposed, sunny, or damp locations, and where a difference in form or leaf texture is desired. Nearly all broad-leaved evergreens need deciduous trees and shrubs to soften and give shade, grace, and airiness to an otherwise rather heavy planting. We take care, however, not to plant surface feeders that in any way interfere with the growth of the rhododendrons, such as maple (*Acer*), poplar (*Populus*), willow (*Salix*), birch (*Betula*), cherry (*Prunus*), privet (*Ligustrum*), honeysuckle (*Lonicera*), and lilac (*Syringa*).

We like to spread our blooming season over a long period of time so that from early spring to late summer there is always color in the garden. After the flowering time is over the brilliant autumn colorings of the leaves of the deciduous trees and shrubs carry on.

In our rhododendron plantings we nearly always use some deciduous azaleas as fillers for an immediate effect. With their radiant clusters of blooms and the tender green of their new leaves they seem to create a feeling of spring that is impossible to achieve with rhododendrons alone. Later on as the rhododendrons mature some of these azaleas may have to be shifted.

Mixed Plantings

As examples of rather good combinations of rhododendrons intermixed with deciduous azaleas I would suggest a drift of *R. augustinii* with *R. luteum* or pale yellow *R. molle,* as they bloom at the same time; or *R. rubiginosum* and *R. yunnanense* with *R. occidentale* and *R. vaseyi.* Another combination might be 'Butterfly,' 'Lady Primrose' and 'Unique' with Schlippenbach's azalea (*R. schlippenbachii*)—the pale yellow of the rhododendrons is very effective against the pale pink of the azaleas.

For the rock garden or a low foreground planting the rhododendrons of the *Lapponicum* series are ideal, but the solid lavender and purple can be broken up with the pinks or pale yellows of rho-

The Chinese daphne, *Daphne retusa,* has proved to be more hardy than the once-popular *Daphne odora.* The plant shown is about 14 inches in height.

Brian O. Mulligan

dodendrons such as *R. keiskei, R. glaucophyllum (glaucum), R. tephropeplum* and *R. pemakoense.*

Mountain-laurel *(Kalmia latifolia)* is a favorite here and is often planted in drifts in the foreground of some of the small-leaved rhododendrons, such as *R. cinnabarinum* and *R. rubiginosum,* intermixed with species of pieris. Or India-hawthorn (*Raphiolepis indica*) may be used in the immediate foreground.

Eucryphias normally grow well here. *Eucryphia nymansensis* and *E. glutinosa (pinnatifolia)* are very good as an accent against the house where a columnar effect is desired, and planted among rhododendrons, *E. intermedia* with its transparent laciness is of great value.

Camellias

Of course *Camellia japonica* and *C. sasanqua* are used everywhere here and normally are very hardy in this climate. Personally I only use camellias espaliered against buildings and walls, where they make an excellent evergreen tracery that does not cover completely as ivy does. I do not like to use them on a south exposure because the wind and rain fade the flowers very quickly. Espaliered in a place where the sunlight never reaches the camellia it will produce many flowers and the foliage will be magnificent.

Other Broad-leaved Evergreens

Impervious to wind and weather, *Ilex aquifolium* in all its varieties is an excellent evergreen background to hide ugly and unsightly places. Planted with other species of *Ilex* and *Osmanthus* and perhaps with a foreground of *Mahonia aquifolium* it makes a rather stunning effect. With all the different variations of leaf color, and the different sizes and colors of the berries of the holly any number of lovely combinations can be made.

While *Daphne odora* has been popular in the past, recent cold winters have reduced its numbers and use against south or west walls or fences. The Chinese *Daphne retusa* is a much tougher, though less fragrant, species, and has the advantage of usually flowering twice in the year, in April and again in August-September. The dwarf *D. cneorum* is still invaluable on the rock garden and prefers a sunny situation.

The photinias are much appreciated in our planting design and the new leaves in the early spring. *Photinia serrulata* does best here in a heavy clay soil, growing to a height of 20 feet, and is of value as a screen planting. It blooms but does not fruit with us. *P. glabra* is smaller in every way but the brilliant red of the early leaves enhances any planting.

Of the evergreen viburnums, *V. tinus* in its several forms, the rather coarse *V. rhytidophyllum,* the semi-evergreen hybrid *V.* x *burkwoodii,* and the invaluable and smallest *V. davidii* are those most commonly employed. The blossoms of *V. tinus* appear through late winter into early spring, are followed by those of *V.* x *burkwoodii* and *V. davidii,* finally by *V.*

rhytidophyllum in May, a plant which should be placed in the background.

We have grown *Magnolia grandiflora* for many, many years. It must not be used in a windy setting. A good substitute plant there would be California-laurel (*Umbellularia californica*). *M. virginiana* is hardier than *M. grandiflora* and, while it is not as showy, its slender beauty lends grace to a planting, and it can be used in damp places where other broad-leaved evergreens thrive.

As wall coverings, the firethorns (*Pyracantha*) are used practically everywhere, and lately so many new varieties have been introduced with berries of different hues that their popularity has increased. But without intelligent and proper pruning they certainly very soon grow out of bounds.

For a screen planting that does not require very much care, the different species and varieties of *Escallonia* are excellent and should be given consideration in any planting list.

In dry, exposed areas or in rock gardens, the rockrose (*Cistus*) species are very valuable. They produce an abundance of color and fragrance during a greater part of the summer and generally do not suffer from our wet winters.

Though perhaps the heathers *(Calluna)* and heaths *(Erica),* strictly speaking, are not broad-leaved evergreens—their leaves are narrow and needle-like—in an article of this kind they should be mentioned, especially as we like them very much and use them extensively in our plantings. The species and their hybrids flower at altogether different times of the year and they also have distinctive foliage colors of brown, bronze, pink and yellow besides the green. With their abundance of blooms in white, pink, purple, and red all through winter, summer, and until late autumn, they seem very necessary in our gardens. The tree heath (*Erica arborea* var. *alpina*) is particularly wonderful here, growing to a height of 7-8 feet with white flowers and good foliage.

Marjorie J. Dietz

Firethorn (*Pyracantha coccinea*), with its long-lasting orange-red berries, is a popular shrub for covering walls. Annual pruning is needed to keep it within bounds.

Camellias can be grown in tubs for display during their blooming periods. After blooming, the tubs can be moved to less conspicuous sites but where they will thrive and form buds for the next season's bloom.

CAMELLIAS IN THE PACIFIC NORTHWEST

Edward M. Lewis

CAMELLIA growers find the temperate climate of the Pacific Northwest ideal for this shrub's requirements. The coastal areas of Oregon, Washington and the Puget Sound region are especially suitable for camellias. Several hundred plants grow in a woodland setting at the University of Washington Arboretum in Seattle. Also, Portland and the surrounding area support the Oregon Camellia Society, which has a flower show every year.

Semi-shade is desirable for all camellias, but a few varieties of *Camellia japonica* and nearly all varieties of *C. sasanqua* will tolerate full sun. Light pink and white-flowered varieties are most apt to sunburn. East and north exposures are good. Deciduous and coniferous trees provide the right amount of filtered shade.

Companion Plants and Landscaping

Trees including oaks, tall pines, magnolias, stewartia and franklinia are good. Shrubs such as azaleas, rhododendrons, osmanthus and many hollies go well with camellias. Other plants providing color throughout the summer include begonias, fuchsias, primulas and many of the lilies.

Camellias make excellent plants for ground covers, shrub borders, hedges, specimens and espaliering. Many camellias are grown in containers outdoors as well as in greenhouses. Specimen plants in tubs can readily be displayed during their blooming period and then moved to protected sites as necessary during inclement weather. Many *C. japonica* cultivars are used for corsages and flower arrangements.

Planting

Three conditions are important for a healthy camellia: good drainage, partial shade, and shallow planting. Choose a planting site with partial shade from the midday sun. Also, protection is needed from north winds by a structure or other shrubs. Camellias require good drainage, a cool moist root area and neutral or slightly acid soil.

A good planting mixture consists of 1 part loamy soil, 1 part peat moss or fine bark, 1 part sand or pumice and 1 part leafmold or compost. Combine ¼ cup superphosphate and ¼ cup dolomite with 1 teaspoon of FTE (trace elements), then add to 12 gallons of above mixture.

Dig the planting hole at least 30 inches wide, 18 inches deep and discard the poor soil. Loosen the bottom of hole with a spading fork. With the above prepared mixture, fill and pack the hole to a point where the camellia ball will be 2 to 3 inches above the level of the surrounding ground. Place the root ball in the hole

and turn plant to the south or to the best light exposure. Place a stake to support the plant during the first year. It is important not to plant too deeply. Fill in around the planting hole (do not pack) and settle with water. Make a small ridge around the edge of planting hole to retain water. To provide a cool root area, apply 2 inches of mulch. Oak leaves, pine needles, coarse bark or wood chips are good. Do not mulch with peat moss, fine bark or sawdust, which tend to "thatch" and shed water.

Keep root area moist with thorough watering. Do not feed the camellia the first six months after planting. Small, newly started camellias are better off growing in a container the first three years of their lives, but plants in pots need careful attention paid to their water requirements.

Feeding and Pruning

Fertilizer requirements will vary with different soils and different areas and whether the camellia is planted in the open ground or in a container. Each grower will have his own favorite soil mix and feeding program. Fertilizers usually include cottonseed meal, well-aged manure, dry or soluble fertilizer. In the Northwest, our soil is naturally acid so we do not have to use an acid type of fertilizer. Occasionally an iron deficiency will occur which is corrected by the use of iron chelates or iron sulphate.

It is better to feed camellias a small amount often rather than a large amount once. Usually two or three feedings during the growing season will suffice. The first feeding in the spring after flowering should be high in nitrogen to promote new sturdy growth. The second feeding should be done when the flower buds start, to help them develop. In autumn a good feeding of manure or cottonseed meal with its slow acting non-burning food supply, carry the plants through winter.

Good general pruning practices apply to the camellia. Try to maintain the natural shape of the plant; a low spreading type should be allowed to spread and a bushy upright type should be allowed to grow upright.

J. A. Witt

'Donation', a hybrid camellia (*C. saluenensis* x *japonica*), with orchid-pink flowers.

The camellia, a slow-growing plant, requires very little pruning. Remove growth that touches the ground by cutting back to side shoots. Small wiry branches arising on the main trunk are unproductive and can be removed. Maintaining an open airy plant is desirable. Long spindly shoots may be induced to branch by removal of nearly all of the current season growth on the shoot. The time to prune is during and after flowering when growth buds begin to swell.

Pests and Diseases

The strawberry root weevil is apt to become a problem if steps are not taken to prevent it. Current controls call for applications of chlordane dust or Cygon liquid around the root area every couple of years.

Spot control of aphids on tender new shoots may be required. This region is relatively free from scale damage but controls should be applied when needed with a summer oil spray.

Camellia flower blight (*Sclerotinia camelliae*) is a fungus disease that attacks the flowers. It does not affect the plant itself. It does not spread from flower to flower, but from ripened spores the following spring to newly developing flowers. The best control is cleanliness, a com-

Don Normark

'Mary Christian' is a *williamsii* hybrid.

J. A. Witt

Camellia x *williamsii* 'J. D. Williams'.

plete removal of all fallen blooms. It is not a real problem here.

Types

The japonicas are widely grown here for their brilliant coloring and large glossy, dark green leaves. The blooming season extends from February through mid-May.

The sasanquas are becoming popular for their early autumn flowering, some starting in October and continuing through February. The hiemalis and vernalis types are usually sold as sasanquas. This group responds well to pruning, making them excellent for espaliers and ground covers.

The reticulatas are the largest and most enchanting of all the camellias. Their blooms must be protected from frost so in this area the shrubs are grown in greenhouses. Most camellia fanciers include this group in their collection.

Cultivars

The following is a partial list of choice camellias which do well here:

Camellia japonica. (Pink) 'Magnoliaeflora', 'Elegans', 'Grandiflora Rosea', 'Kumasaka' and 'Hawaii'.

(White) 'Finlandia', 'Auburn White', 'Gwenneth Morey', 'Amabilis', and 'Silver Anniversary'.

(Red) 'Flame', 'Guilio Nuccio', 'Glen 40', 'Grand Prix' and 'Tom Knudsen'.

(Variegated) 'Sunset Oaks', 'Betty Sheffield Supreme', 'Tinsie', 'Glen 40 Variegated' and 'Ville de Nantes'.

C. sasanqua. 'Setsugekka' (white), 'Mrs. Jean Wilcox' (white) and 'Jean May' (pink).

C. hiemalis. 'Shishi-Gashira' (red), 'Showa-No-Sakae' (pink), 'Chansonnette' (pink).

C. vernalis. 'Hiryu' (red),

C. reticulata. (Greenhouse culture only) 'Captain Rawes' (rose pink), 'Francie L.' (rose pink), 'Howard Asper' (salmon pink), 'Highlight' (brilliant red) and wild form (outdoor-grown with some protection).

Hybrids: (*saluenensis* x *japonica*), 'Brigadoon' (rose pink), 'Donation' (orchid pink) and 'J. C. Williams' (phlox pink).

CAMELLIAS IN CALIFORNIA

. . . suggestions applicable to many regions

William E. Wylam

CALIFORNIA is a big state and the sections where camellias may be grown are many and varied, both as to climate and soils. However, in general, these sections may be grouped into two divisions—the cool, humid coastal region, where there is a minimum variation between day and night temperatures, and the interior valleys which have a daily wide range of temperatures and which are hot and dry in the summer. It may be well to note at this point that camellias in coastal areas need far less shade than those planted in interior valleys.

Native Habitat

In their natural habitat, camellias are usually found as secondary growth on wooded slopes, in areas of considerable rainfall. Soils are well drained and have an acid reaction. If similar conditions are provided they respond most gratifyingly.

Correcting Alkaline Conditions

The Central Valleys and Southern California are regions of light rainfall and in many sections the soils are alkaline. In some areas the water is also alkaline. To counteract these conditions, many growers use a large percentage of peat in their soil mix. Soil sulfur is sometimes used to correct alkalinity, as are ferrous sulfate and magnesium sulfate; iron chelates or "stabilized iron" are also used. Aluminum sulfate is not recommended for California conditions because of its residual salts. Perhaps the best method of preventing damage by alkaline and saline conditions is periodically to leach the soil by heavy flooding to remove the excess alkaline salts. However this also removes some of the necessary nutrients which need to be replaced.

In growing camellias there are three practices which must be followed to secure optimum results. First, and possibly most important, is shallow planting. The feeder roots should be just below the surface of the soil. Second, the soil should contain a large percentage of humus. This helps in supplying needed acidity. The third requirement is good drainage. Nothing will kill camellias as quickly as soggy soils which prevent the roots from obtaining needed oxygen.

Fertilizers

Various organic fertilizers such as cotton seed meal, castor pomace, and the commercial "organic plant foods" are largely used. Many follow the practice of fertilizing lightly at intervals of approximately 6 weeks, from the middle of April to the end of August. Fertilizing during the fall and winter is apt to induce tender growth which may be injured by frost.

By selecting camellias that bloom at various seasons, Californians are able to enjoy camellia flowers from September to late May. Some camellias seem to do equally well in all sections whereas others are superb in one section and mediocre in another. As a general rule, 'Mathotiana alba' and the other late formal types are best adapted to cool, humid areas, while 'Lindsay Neill' and similar camellias are apt to have small blooms in such areas but are spectacular in the interior valley.

Varieties

Japonicas still predominate and among those which are popular in many areas are several which should be listed by "families" rather than as individuals. An example of this is the Donckelari Group which includes the various forms of 'Donckelari' (*Siebold*)—'English', 'Southern', 'Tallahassee', 'Tea Garden', etc.—'Eugene Bolen', 'Eugene Lize', 'Lady Kay', 'Ville de Nantes' and possibly

other cultivars. These "families" also include other groups such as 'Betty Sheffield', 'Daikagura', 'Elegans', 'Finlandia', 'Herme', and 'Tomorrow'. Among other popular camellias are:

'Adolphe Audusson'—dark red
'Alba Plena'—white
'Debutante'—light pink
'Drama Girl'—carmine rose
'Frizzle White'—white
'Gigantea'—crimson splashed white
'Glen 40'—turkey red
'Guest of Honor'—salmon pink
'Guilio Nuccio'—coral rose pink
'Kramer's Supreme'—turkey red
'Lallarook'—pink marbled white
'Mathotiana'—crimson, with purple cast
'Mrs. D. W. Davis'—blush pink
'Purity'—white
'Reg Ragland'—crimson
'Wildwood'—light pink

It is true that many Californians know only of the japonicas and regard camellias simply as a source of exquisite cut flowers or as single specimen plants rather than as superb landscape material. However, as the public learns of the hardy sasanquas and the spectacular Yunnan reticulates and other newly discovered species, and their hybrids, a rapidly growing interest in landscaping with camellias is becoming evident.

More and more people are becoming aware of the value of the beautiful camellia foliage, the character of which is such that it readily adapts itself to any situation, from a formal planting to the exotic tropical effects created as a setting for the bold architecture currently popular.

Marjorie J. Dietz

Camellias do have their favored growth regions where generally mild climates suit their culture, such as the Pacific Northwest, parts of California, the South. However, occasional plants do exist out of these benign climates, as is proved by this *Camellia japonica* 'Sweetheart' which has been flowering annually on eastern Long Island for over fifteen years.

SASANQUA CAMELLIAS AUTUMN TREASURES

How to use and care for these long-neglected but very worthwhile shrubs

Francis de Vos

SASANQUA camellias have been in cultivation since at least the mid-1800's. Only in the last 30 years have they emerged from the shadow of their illustrious cousin, *Camellia japonica*. Some of the reasons for this long period of obscurity are, paradoxically, the same as those for which they are acclaimed today, namely, single flowers, early flowering, and open growth habit.

Landscape Merits

Double and semi-double camellia flowers have long been favored by the public over single-flowered types. Since most sasanqua blooms are single they were passed over along with many of the single-flowering japonicas. In recent years, however, gardeners have come to a greater appreciation of the fact that simplicity is an attribute of beauty.

The fall-flowering characteristic of the sasanqua camellias, which was once a liability, is now considered one of their greatest assets. No other woody plant grown in temperate regions can match the lateness and showiness of their floral display, which starts in late September and continues until frosts cut them down in late November.

The loose open growth habit of many sasanqua varieties was long considered one of their main drawbacks as a garden plant. Along with a greater appreciation for single flowers has come an awareness that the long slender branches clothed in glossy dark green foliage add an artistic touch to the garden that cannot be obtained with most japonica varieties, or with many other plants. There are also compact and low spreading types among the 200 or more varieties of this versatile species being offered by the nursery trade. The excellent evergreen foliage of the varieties 'Willow Leaf' and 'Hugh Evans' makes good background for flowering deciduous shrubs. The varieties 'Cleopatra', 'Rosea', 'Narumi-Gata', and 'Tanya' can be made into outstanding hedges. Almost all varieties can be effectively espaliered.

Hardiness and Range of Usefulness

Contrary to popular belief the *Camellia sasanqua* is no more and perhaps even less cold-hardy than *C. japonica*. Where a limited number of varieties of the two species have been grown together in areas that experience 0° F. or below, the japonicas have invariably stood up better. However, most of these tests are too inconclusive to permit any definite conclusions about their relative bush-hardiness. There is, however, a marked difference in the bud-hardiness of the two species. Observations at the U. S. National Arboretum on a number of sasanqua varieties revealed that temperatures below +18° F. so severely damaged unopened buds that they failed to open, or if they did open the flowers were of very poor quality. Most *C. japonica* varieties will withstand temperatures of at least +15° F. in bud without serious impairment of the flower quality.

The present range of usefulness of sasanquas for their flowering effect extends along the Pacific Coast from southern California to Washington state, throughout the South and along eastern seaboard to Washington, D. C. Scattered small but successful plantings outside this range indicate that sasanquas can be adapted to colder regions if given some protection. The principal barrier to their successful culture from Washington, D. C., northward, in areas where they would be bush-hardy, is the slower rate of bud development. Since high temperatures are necessary for bud development and early flowering, plants in cooler regions would

U.S. National Arboretum

Camellia sasanqua 'Miss Auburn' has single flowers that are white and pink. It blooms in early November in Washington, D. C.

not flower in time to escape freezing temperatures. The flowering time for any particular variety becomes progressively later the farther north it is grown. A case in point concerns the outstanding double white variety 'Mine-No-Yuki' which is highly satisfactory from Norfolk, Virginia, southward but will flower only one year in three before cold weather sets in.

Culture

Sasanquas are easy to grow. Their ease of culture is somewhat reflected in the fact that hundreds of thousands are used each year as understock for japonica varieties. Their vigorous, compact root systems assure successful transplanting and rapid re-establishment. Although barerooted 1-and-2-year-old plants can be reestablished, best results have been obtained with canned or balled stock.

The basic cultural requirements for sasanquas are a well-drained acid soil that is fairly high in organic matter and a surface mulch of such organic material as pine mulch or leaves. Sasanquas can be grown in full sun where they develop their maximum compactness and greatest flower production, or in full shade where they are sparse-flowering and usually open in habit. A site that receives one-half of full sunlight or its equivalent each day and some winter shade is best. Late-blooming varieties sould be planted in the sunniest locations so they will bloom before the critical temperature of 18° F. is reached in late fall.

Camellias are generally planted during the late fall and winter months in the South. For colder regions spring planting seems to be best as it enables the plant to become well established before cold weather sets in. The most important thing to keep in mind about the actual planting operation is that plants should not be set any deeper than the level at which they had been previously growing. Deep planting is one of the major causes of camellia failures following transplanting.

The question of how much fertilizer to use on camellias depends to a great extent on the level of nutrients in the soil in which they were planted and the natural surrounding soil mass. The soils at the Norfolk Botanical Gardens in Norfolk, Virginia, are apparently high enough in nutrients to grow excellent camellias year after year without fertilizing. Since most gardeners do not have such soils, one application of cottonseed meal at the rate of 15 pounds per 1000 square feet (8 to 10 ounces per plant), or a commercial azalea-camellia fertilizer, applied as directed, just prior to new shoot growth in the spring should suffice.

Propagation

Although sasanquas can be propagated from cuttings taken at any time after the new growth has become slightly hardened,

best results have been obtained in the Washington, D. C. area with cuttings taken from late July through September. Cuttings treated with root-inducing powders will root within 6 to 8 weeks.

Troubles

The sasanqua is virtually a trouble-free shrub. Infestations of scale, mites, and aphids are usually light and can be controlled by spraying with malathion.

Varieties

Although there are 200 or more sasanqua varieties being offered by the nursery trade, only a small number consistently appear on the recommended lists of growers and collectors. The following varieties are among the most popular at present and are generally available. The list was compiled by the United States National Arboretum, Washington, D. C.

RECOMMENDED CAMELLIAS FOR THE WASHINGTON AREA

White

'Cherokee'—Semi-double
'Dawn' *(vernalis)*—Single to semi-double
'Hino-de-Gumo'—Single
'Mine-No-Yuki'—Semi-double
'Setsugekka'—Semi-double
'White Glory'—Single

Light Pink

'Agnes O. Solomon'—Semi-double to double
'Apple Blossom'—Single
'Betty Patricia'—Rose form double
'Cotton Candy'—Semi-double
'Jean May'—Rose form double
'Maidens Blush'—Single
'Papaver'—Single
'Pink Snow'—Anemone form to semi-double
'Rosy Mist'—Single

Deep Pink to Rose

'Cleopatra'—Semi-double
'Crimson Tide'—Single
'Orchid'—Single
'Shishi-gashira *(hiemalis)*—Semi-double
'Showa-no-sakae'—Semi-double to rose form double
'Sparkling Burgundy'—Peony form
'Velvety'—Single

Red

'Bonanza'—Semi-double
'Hiryo *(hiemalis)*—Rose form double

Camellia sasanqua 'Narumi-Gata' in bloom in early November in the U. S. National Arboretum. It has semi-double flowers.

The leatherleaf mahonia (*Mahonia bealei*) has imposing yet rather stiff evergreen foliage. The shrub looks best in a fairly formal setting.

George Taloumis

BROAD-LEAVED EVERGREENS IN THE SOUTH

Kinds to use, how to grow them, and suggestions for landscape use

James J. Franklin

MUCH of the charm of the Deep South is found in its spreading live oaks, bright flowered winter-blooming camellias and azaleas, trim, symmetrical boxwood hedges, and its magnolias with plate-sized fragrant blossoms. All of these, and more, are broad-leaved evergreens. In fact, a large portion of the plants used in landscaping throughout the Gulf and southern Atlantic states are broad-leaved evergreens. Ten of the leading nursery firms of the area list over 150 kinds.

In the camellia growing areas there is at least one gardener in every town who has a planting of 50 to 100 varieties of camellias; some enthusiasts grow several hundred different varieties. Likewise, home azalea plantings frequently contain 10 to 20 varieties.

Reason for Success

The widespread use of broad-leaved evergreens throughout this mild-winter region is partly due to the rare occurrence of very low temperatures combined with drying winds, a combination that generally spells trouble for broad-leaved evergreens. The soil surrounding shallow root systems such as many broad-leaved evergreens possess may freeze easily. If wind or sun cause loss of water from the leaves while this condition exists, winter burn results. Conditions causing witner burn are rare in most of the South.

Other reasons for the success southern gardeners have with broad-leaved evergreens are the moist climate with rainfall rather evenly distributed throughout the year, and soils that are for the most part slightly acid.

Soil and Light

The native broad-leaved evergreens of the region are not found everywhere. They grow chiefly under a partial cover of deciduous trees in moist but well-drained soils containing a large proportion of leafmold. When attempting to grow such plants on properties from which the trees have long since been removed, it is usually

Margaret Perry

Brian O. Mulligan

The garden of the Governor's Palace at Colonial Williamsburg features American holly (*Ilex opaca*) in clipped form to make the maze and as standard trees to serve as upright accents. *Right:* Flowers and evergreen foliage of *Pittosporum tobira.*

necessary to add organic matter such as leafmold or peat moss to the soil. Where soils are heavy (clay) it is advisable to add sand as well as organic matter to lighten them, especially for azaleas, rhododendrons, and camellias. It is not always necessary to supply the partial shade found in most natural environments of broad-leaved evergreens. Mature plants of many species do fully as well in full sun, and frequently flower or fruit more freely than in shade.

Tolerant Kinds

In addition to acid-loving broad-leaved evergreens in the South is the rather large group that also succeeds under neutral or slightly alkaline soil conditions, such as euonymus, ivy, jasmine, abelia, barberry, some hollies, privet, firethorn, most viburnums, and yucca. Some, such as privet, spreading euonymus, primrose jasmine, laurestinus viburnum, Carolina cherry-laurel, firethorn, and elaeagnus, can thrive in dry situations; while inkberry, coast leucothoë, rosebay rhododendron, mountain-laurel, common oleander, sweetbay magnolia, and live oak succeed in swampy or boggy places.

Transplanting

In the Upper South (Zone 7 and north) where the soil freezes at times in winter, broad-leaved evergreens are best transplanted in the spring. It is possible to move them in the fall if it can be done early enough so they are partially established before cold weather sets in, and if they are given protection from winter sun and wind.

Near the Gulf of Mexico and in the coastal regions of the South Atlantic States, transplanting may be safely done at any time from fall to spring. Plants that are less than 3 years old generally survive transplanting best and make maximum growth afterward when planted in partial shade and mulched.

Fertilizing

It is most important to the success of a new planting that it be in the proper location in respect to soil type and sunlight. Lacking this, proper preparation of

George Taloumis

The southern magnolia (*Magnolia grandiflora*) makes a handsome espalier against the house wall and serves as a pleasant evergreen backdrop for the terrace.

a less suitable area to make it approach the ideal is necessary. Once broad-leaved evergreens are established in landscape plantings, they need only modest fertilization unless rapid growth is desired.

When preparing a new bed area for broad-leaved evergreens it is advisable to insure ample phosphorus for the first year's growth by incorporating superphosphate into the soil at the rate of 5 pounds for each 100 square feet of bed area. As this goes into the soil very slowly from a surface application, it should be worked into the soil to a depth of 8 to 12 inches.

Plants which have been established by fall or winter planting can be given a complete fertilizer 2 to 3 weeks before new growth begins. Or a split application can be made—half before growth in spring and half after flowering. For some plants such as camellias in which bud development and new growth occur at the same time, the second application might be best in mid-summer. But fertilizers containing readily available nitrogen are not safely applied between the middle of August and early spring, as they may encourage new growth at a time when cold spells will kill it back.

As to fertilizers: cottonseed meal or soybean meal applied at the rate of 5 pounds per 100 square feet are ideal for small plants. For large plants a 5-10-5, or other complete fertilizer with similar formula, may be applied at the rate of 2 to 4 pounds per 100 square feet. These complete fertilizers are safer and more satisfactory if from ¼ to ⅓ of their nitrogen content is derived from cottonseed or soybean meal. To fertilize individual plants, use 2 to 3 ounces of the fertilizer for a shrub with a spread of 3 feet. For trees apply at the rate of 2 to 3 pounds for each inch diameter of the trunk.

How often fertilizer is applied depends on the kind of plant and the growth response desired. Heavily flowering and fruiting plants may need to be fertilized annually, if quality is to be maintained, but others may not need to be fertilized oftener than every 3 to 5 years. A mulch 1½ to 2 inches deep should be maintained, however.

Marjorie J. Dietz

Boxwood is a most versatile landscaping shrub. When allowed to grow without any pruning or shearing, plants assume picturesque shapes that continue to improve with age.

Japanese holly (*Ilex crenata* 'Hetzii') makes an attractive hedge that can be kept within bounds by shearing.

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Pest Control

Lace bug is a more serious pest in the South than in the North, because of the longer breeding period. It attacks many broad-leaved evergreens. In some areas it is largely responsible for the failure of cotoneasters. Firethorn foliage is sometimes completely discolored by the end of the season, although the crop of berries does not seem to be reduced. The foliage of azaleas and rhododendrons should be carefully inspected periodically, as lace bug can spoil its appearance in a short time. Malathion or Sevin sprays are effective.

If wild black cherry (*Prunus serotina*) is a host of lace bug, it should be eliminated from the vicinity of plantings of broad-leaved evergreens or included in a well-timed lace bug spray program.

Note on Propagation

In the lower South where there is no freezing and heaving of the soil, hardwood cuttings (with leaves) of a number of broad-leaved evergreens can be lined-out in open, partially shaded beds in midwinter and successfully rooted. Boxwood, jasmine, firethorn, and barberry are a few which can be increased in this way.

Rate of Growth

In the coastal areas in Zone 9 vegetative growth in one season is frequently two or three times greater than it is in areas which are drier or have shorter seasons. It is well to remember this when spacing plant material for landscape planting along the coast. If ample spacing is neglected, frequent pruning and even removal of crowded plants may be necessary.

Landscape Value

Where broad-leaved evergreens thrive they are naturally the "kings" of the plantings. In addition to their special contribution of year-round foliage, they are often productive of handsome flowers and ornamental fruit. Broad-leaved evergreens are varied in size and in form, have a wide range of growth rate from very slow to moderately rapid, and present many different foliage color variations and textures.

For hedges and screen plantings broad-leaved evergreens are unsurpassed, and as foundation plants they are graceful and blend well with architectural materials and with other plants. Some of them are excellent as specimen plants, others in groups or borders. Not to be overlooked are the valuable evergreen vines.

Of the more than 150 species of broad-leaved evergreens commonly used in the South, the following lists contain some of the best, grouped according to their special uses in landscape planting.

LANDSCAPE USES OF BROAD-LEAVED EVERGREENS IN THE SOUTH

Hardier plants are indicated by a number showing to what zone north they can be grown, so lists can be used for landscape suggestions by gardeners outside the South (see map in centerfold).

For Outstanding Flowers

Glossy Abelia (5) (*Abelia grandiflora*)
Scarlet Bottlebrush (*Callistemon coccineus*)
Camellia (5) (*Camellia japonica* and *C. sasanqua*)
Gardenia (*Gardenia jasminoides*)
Carolina Jessamine (vine) (*Gelsemium sempervirens*)
Jasmine (*Jasminum* spp.)
Mountain-laurel (4) (*Kalmia latifolia*)
Southern Magnolia (tree) (*Magnolia grandiflora*)
Sweetbay (tree) (5) (*Magnolia virginiana*)
Banana Shrub (*Michelia fuscata*)
Oleander (*Nerium oleander*)
Sweet Osmanthus (*Osmanthus fragrans*)
Japanese Photinia (*Photinia glabra*)
Chinese Photinia (*Photinia serrulata*)
Pittosporum (*Pittosporum* spp.)
Cherry-laurel (6) (*Prunus laurocerasus*)
Yeddo Raphiolepis (*Raphiolepis umbellata*)
Rhododendron, in South for high altitudes only (3-4) (*Rhododendron* spp.)
Indica Azalea (Hybrids of *Rhododendron indicum, R. simsii,* and others)
Kurume Azalea (5) (*Rhododendron obtusum* hybrids)
Laurestinus (*Viburnum tinus*)
Bigleaf Periwinkle (ground cover) (*Vinca major*)

For Outstanding Fruit

Thorny Elaeagnus (*Elaeagnus pungens*)
Spreading Euonymus (6) (*Euonymus kiautschovicus*)
Burford Chinese Holly (5) (*Ilex cornuta* 'Burfordii')
American Holly (tree) (5) (*Ilex opaca*)
Yaupon (*Ilex vomitoria*)
Southern Magnolia (tree) (*Magnolia grandiflora*)
Sweetbay (tree) (5) (*Magnolia virginiana*)
Leatherleaf Mahonia (6) (*M. bealei*)
Partridge-berry (ground cover) (3) (*Mitchella repens*)
Southern Wax-myrtle (*Myrica cerifera*)
Nandina (*Nandina domestica*)
Chinese Photinia (*Photinia serrulata*)
Firethorn (6) (*Pyracantha* spp.)
Skimma (6) (*Skimmia japonica*)

For Hedges

Convex-leaved Japanese Holly (5) (*Ilex crenata* 'Convexa')
Yaupon (*Ilex vomitoria*)
Japanese Privet (*Ligustrum japonicum*)
Chinese Privet (*Ligustrum sinense*)
Carolina Cherry-laurel (6) (*Prunus caroliniana*)

For Screen Plantings

Thorny Elaeagnus (trained) (*Elaeagnus pungens*)
English Ivy (trained) (5) (*Hedera helix*)
Yaupon (*Ilex vomitoria*)
Devilwood Osmanthus (*O. americanus*)
Chinese Photinia (*Photinia serrulata*)
Cherry-laurel (6) (*Prunus laurocerasus*)

Doorway and Wall Plantings about Buildings

Aucuba (*Aucuba* spp.)
Barberry (5) (*Berberis* spp.)
Boxwood (5) (*Buxus* spp.)
Camellia (5) (*Camellia japonica* and *C. sasanqua*)
Spreading Euonymus (6) (*Euonymus kiautschovicus*)
Showy Jasmine (*Jasminum floridum*)
Mahonia (6) (*Mahonia* spp.)
Nandina (*Nandina domestica*)
Yeddo Raphiolepis (*R. umbellata*)

Specimen Trees

American Holly (5) (*Ilex opaca*)
Southern Magnolia (*M. grandiflora*)
Live Oak (*Quercus virginiana*)

Vines (on bricks and stone)

Climbing Fig (*Ficus pumila*)
English Ivy (5) (*Hedera helix*)

A report from eastern Ohio

BROAD-LEAVED EVERGREENS BORDERING THE APPALACHIAN REGION

Paul R. Bosley

To MANY PEOPLE in the eastern United States, Ohio is where the West begins. This is true to the extent that there is a line splitting the state down the middle, even down the main street of the capital city, that marks a boundary between soils characteristic of much of the West and those typical of the East.

To the east of this line are acid soils—and a paradise for broad-leaved evergreens. To the west the soils have largely a limestone base and are neutral or alkaline—cornfields stretch as far as the eye can reach across the Great Plains to the Rocky Mountains, but many of the finest broad-leaved evergreens are unable to grow at all here.

So far as climate is concerned, cultural directions for growing broad-leaved evergreens in Ohio will also apply to all of Zone 5 and the warmer parts of Zone 4. But the information concerning the many acid-loving plants applies only to Pennsylvania, Virginia, and West Virginia, and the eastern halves of Ohio and Kentucky.

While the rhododendrons and azaleas—the glory of spring in the northeastern section of Ohio, as well as kalmia and pieris, absolutely must have acid soil in order to live, the situation is not entirely hopeless for gardeners in the alkaline soil regions. American holly (*Ilex opaca*), the forms of Japanese holly (*I. crenata*), euonymus, boxwood, and mahonia all do quite well in such soils. Euonymus in its various evergreen forms is the "poor man's aristocrat" among the broad-leaved evergreens. Boxwood (*Buxus*) is not particularly at home this far north, but there are several forms that are hardy enough to be used in this area. The same is true for the hardier forms of English ivy (*Hedera*).

Rhododendron Culture

Among the acid-lovers, rhododendrons and azaleas are the favorites. They were

Marjorie J. Dietz

Rhododendrons are among the most popular shrubs in the eastern Ohio region now that their culture is better understood. Evergreen azaleas are also widely grown.

Mountain-laurel (*Kalmia latifolia*) is native over a wide region—from Maine south to Florida and the Gulf States, west to Indiana and Tennessee. Home gardeners within this vast region find this shrub one of the most reliable and rewarding of flowering evergreens.

George Taloumis

long considered difficult plants to grow, but now their cultural requirements are well enough understood that gardeners are assured of success. In addition to their need of acid soil, they have shallow roots which require air—therefore light, porous soil is a necessity. These plants can be grown better standing on top of the soil than in a heavy soil, even an acid one. Peat moss that is thoroughly moist before being dug into the garden soil provides the best way of maintaining long-time porosity.

Few gardeners realize the importance of removing the faded blooms so the entire strength of the plant may be devoted to making buds for the following year's blossoms.

Azalea and Rhododendron Varieties

If I had but one evergreen azalea to choose, it would be 'Fedora' because of its absolute dependability under adverse conditions. Many of the earlier hybrids have been discarded, but some of the later ones are proving to be wonderful varieties. Among other things, the late Joseph Gable produced new varieties of azaleas that will not set a heavy crop of seed, and thus drain the vitality of the plant and reduce its bloom the following year. Among his achievements that are worth remembering and asking for are: 'Herbert', 'Rose Greely', 'Louise Gable', 'James Gable' and 'Stewartsonian'.

The so-called Catawbiense hybrids are the most widely planted rhododendrons in the eastern Ohio region. 'Cunningham's White', perfectly hardy here, is a classic example of a fine foliage type, the demand for which has never been satisfied.

The special hardy Dexter rhododendrons that were so carefully accumulated during Mr. Dexter's lifetime, bloom so profusely as to completely envelop the plants with flowers. Plantsmen have been working to propagate these forms and a number of superior cultivars of this new class of rhododendrons have become available to gardeners in recent years.

American Holly

A broad-leaved evergreen that has made phenomenal strides during the last decade in reliability and popularity is the American holly (*Ilex opaca*). These hollies can be purchased as named varieties with more or less proven characteristics; many make top-rate garden plants. They withstand city conditions well and can be maintained in any form from a tightly clipped hedge that grows only an inch a year to a splendid plant allowed to develop a foot a year.

(continued)

Heritage Plantation

Rhododendron 'Brandygreen' shows its abundant flowers, typical of Dexter hybrids.

Ninety-eight per cent of the American hollies growing in the wold lack good enough characteristics to warrant their use in a garden, whereas the named varieties are reproduced only from cuttings of the best plants yet discovered.

American hollies can be grown easily enough in sections of the country having alkaline soil. In such soils the iron so necessary if plants are to develop good foliage color is tied up, but the application of iron sulfate or the chelated irons will relieve the chlorosis that may develop in problem spots.

Some varieties of American holly are proving hardy along the southern edge of Canada, in the Toronto area, as well as in Maine and northern Michigan.

The variety 'Hedgeholly' is a very distinctive form with a somewhat smaller leaf than most and a valuable self-branching habit that makes it perfect as a specimen plant and especially as a hedge.

'Santa Claus' is one of the better male hollies, blooming so profusely as to make the flowers a feature of the plant. 'Old Heavy Berry' is a fine plant with glossy leaves approaching those of the less hardy English holly (*Ilex aquifolium*).

'Christmas Carol' is a New England selection which has a narrow habit of growth that makes it admirable for small houses on narrow lots.

We have just recently noted that birds do not particularly like the berries of the variety 'Yule', so it remains pretty in the garden for a much longer time than others. It has proved to be exceptionally sturdy.

Two interesting new male hollies, each with distinctive foliage are 'Kentucky Gentleman' and 'Jersey Knight'. It is generally thought that male hollies are more drab but not so with these two.

The Holly Society of America has been the means of bringing together holly growers and lovers, and is promoting this fine native American plant which may well become one of the outstanding plants for American gardens.

Other Hollies

The average gardener does not think of the Oriental forms of *Ilex* as holly, but they are important broad-leaved evergreens. *Ilex crenata* 'Convexa' is being widely grown and has proved to be a more dependable plant than straight *I. crenata*. Another one which is very good is *I. crenata* 'Hetzii'. It has broader and more pronouncedly turned-back (convex) leaves, and is a leader in the group. *Ilex crenata* 'Rotundifolia' gives bolder effects, while varieties like 'Stokes' are slow-growing and dainty.

Landscape Uses

During the last decade the pendulum of popularity has swung from an exaggerated use of narrow-leaved evergreens (conifers) toward the greater use of broad-leaved varieties. Rhododendrons are useful for bold massive landscape effects; azaleas, particularly the kaempferi hybrids, can be used for foreground and foundation plantings. Evergreen forms of euonymus make excellent covering for walls or banks. American holly can be grown as specimen plants that eventually become large trees. However, it is easily controlled by shearing and can be held at 8 to 10 feet, or severely trimmed as a formal hedge 4 to 6 feet high. The Japanese hollies make excellent hedges with billowy effects and are easy to control at 18 to 36 inches or higher. For similar but even more dainty effects of this sort, 12 to 18 inches tall, nothing is better than dwarf Japanese hollies such as *I. crenata* 'Stokes' and 'Helleri'.

A history and evaluation . . .

THE DEXTER RHODODENDRONS

John C. Wister

WE OWE the beginning of the culture of hybrid rhododendrons in this country to two Boston amateur gardeners, H. H. Hunnewell and Edward S. Rand. On visits to England in the late 1850's and 1860's they happened to see the displays of Anthony Waterer's Knap Hill Nursery.

They imported plants which did so well in their gardens that, in 1876, Waterer ventured to send a great collection of some 1,500 Catawbiense hybrids in fifty or more varieties to the Centennial Exposition in Philadelphia.

These plants with their many-colored flowers created a sensation. For the next quarter-century Anthony Waterer and other European growers found a lucrative market for their plants in the New England and Middle States. Here the foundation was laid for the present day rhododendron enthusiasm.

After the turn of the century, however, British breeders began to work with newer and less hardy species than those which had produced the so-called "Iron-Clad" Catawbiense hybrids. Most of those could not withstand the combination of too cold winters and too hot and dry summers which are characteristic of our East Coast. They did, however, flourish on our West Coast from San Francisco to Seattle and British Columbia. Their history, culminating in the organizing of the American Rhododendron Society and various regional or local societies, is well known to rhododendron hobbyists.

Eastern gardeners long envied the West Coast growers who could enjoy these magnificent new flowers. Various Eastern breeders tried their hand at producing hybrids of similar beauty, yet adapted to eastern conditions.

One of these was the late Charles O. Dexter. In the early 1920's he retired from business and bought land at Sandwich on Cape Cod. Apparently, entirely by chance, he employed as the landscape architect for his new place Paul Frost, a life-long rhododendron enthusiast. Frost knew that Cape Cod conditions were ideal for rhododendrons and persuaded Charles Dexter to buy out most of a great collection which John Farquhar, a Boston seedsman, had imported before the days of the Plant Quarantine.

Beginning of the Dexter Collection

The flowers on these then little-known species and hybrids were so much finer than any previously seen in those parts that Dexter was fascinated. Paul Frost quickly persuaded him to make crosses and raise seedlings, reporting this to Professor Sargent and E. H. Wilson at the Arnold Arboretum.

They at once began to help Dexter by supplying additional species and by arranging for shipments of pollen of rare species and hybrids from England. Here was an example of how the professional staff members of an Arboretum can lend such a hand to an amateur breeder that his work achieves importance. Many amateurs have, without previous training, made noteworthy contributions to horticulture and most of them could obtain help from our horticultural institutions if they asked for it.

Charles Dexter's work achieved definite and important results. From the strictly scientific point of view, however, it had its drawbacks. The exact status of some of the first plants he used for hybridizing is clouded with considerable doubt.

The Dexter estate, now called Heritage Plantation, is open to the public. It recently announced a subscription plan to gardeners for the gradual distribution of previously unavailable Dexter hybrids. Details are available from the Plantation, Grove and Pine Sts., Sandwich, Massachusetts 02563.

Heritage Plantation

Rhododendron 'Dexter's Horizon', one of the original Dexter hybrids at Sandwich.

One of his best Farquhar plants, which he numbered #8, had come from Robert Veitch in Exeter, England, under the name of *R. fortunei.* While the Veitch nursery was careful, this plant differed enough from the typical species as to raise the possibility that it was really an accidental hybrid crossed by bees.

Mr. Dexter left no written records and apparently relied upon memory in writing on his labels the parentage of his hybrids. Some people state he became so forgetful that he placed the same code number on entirely different plants.

When the plants from his crosses began to bloom, the flowers were so unusual and so beautiful that they soon attracted many visitors. Although he was not anxious to part with plants, visitors so importuned him that he began to give away flats of seedlings and even to sell a few larger plants. In this way fifteen, twenty, or more great collections of these plants were started in other places.

Early Selection Neglected

In any plant hybridizing, in addition to a few really fine things which develop, there are great numbers of mediocre plants not worthy of further propagation. That was particularly true of the Dexter hybrids which were loosely called "Fortunei hybrids."

It is clear that there should have been most rigorous selection. If this had been done 99 out of every 100 seedlings would have been destroyed rather than distributed. There would have been better opportunity to concentrate the effort on the very best and to make selections which would by this time be of great value.

As it was, Dexter went happily on with this work, growing some 10,000 seedlings a year over a period of nearly 20 years.

It was only after his death that rhododendron growers began to realize what a great contribution he had made. At that time a small group of men who were interested in rhododendrons got together and began to visit collections where the Dexter seedlings were grown. They found that most of the plants were not distinctive, but among them here and there were some gorgeous new hardy varieties of untold value to the New England climate. What their value will be on the West Coast, where they will have to compete with the finest British varieties, is not yet known.

Characteristics

Among the characteristics of these seedlings are rapid growth and the habit of flowering when extremely young. The flowers, which are large, bloom mostly before the Catawbiense hybrids, that is, in the Philadelphia area in mid-May rather than late May or early June. The flowers are often fragrant. Most are pale pink, but there are some lovely clear deep pinks without any tinge of purple or blue. There are also some very fine scarlets and a few reds, some apricot yellows, and an occasional white. 'Helen Everitt' is said to be white.

Among the men who became interested in these new plants, and who journeyed to visit sixteen different collections were Clement G. Bowers, Donald Wyman, Henry T. Skinner, Paul Vossberg, David Leach, Paul Bosley, and the writer. There were, of course, differences of opinion as to the value of particular plants, but there were also definite conclusions on which all agreed. In the gardens visited these plants were tagged and numbered.

Through the kindness of the owners of the various collections, cuttings were rooted and have been distributed to a number of public collections for further testing. The first of these cuttings came to the Scott Foundation at Swarthmore, and later from there plants were distributed to the National Arboretum, to Planting Fields Arboretum, to the Arnold Arbo-

Marjorie J. Dietz

A view of the Dexter Estate at Sandwich on Cape Cod. Charles Dexter set out many of his numerous rhododendron seedlings throughout the woods that comprised much of his property, and some of these original plants remain. Other plants were removed or lost, but a few deemed outstanding have been propagated and are sold by nurserymen (see list below).

retum, and to some private growers. From these many varied seedlings now known by code numbers, it is hoped that final conclusions will be drawn when they bloom side by side in these places.

The best varieties can then be selected and named, and turned over to nurseries for mass production. In the meantime interested persons can visit the collections where these are being grown and see for themselves the progress that is being made and what the different varieties have to offer.

When the value of Dexter's work was first recognized, great difficulties were experienced in propagation of selected clones. It was not until about the early 1950's that rhododendron propagation by cuttings became successful enough to make it worth while to take cuttings from small rare plants. Much of this work has now been simplified by the use of polyethylene film and hormones. See page 74.

Hardiness

The climatic limitations of these seedlings are not yet fully understood. They have been grown on Cape Cod since about 1924. The earlier ones withstood the severe winter of 1933, the coldest in the history of the weather bureau. Plants have been grown farther north, but near the sea, in Ipswich and in Newburyport, and are said to have withstood many years when the temperature ranged from 10° to 20° below zero F. or even colder. They have been grown in Mentor, Ohio, where there are many cold winters. In one nursery there, they are grown entirely in the open, just like any other field crop, and have stood both sun and wind in winter. In most other places they have been given sheltered locations under trees or sheltered by a hillside.

Charles Dexter's work was only the beginning of what is being done to bring greater variety into the hardiest strains of rhododendrons, and to make it possible to grow rhododendrons in areas where they were little known before.

Named Dexter rhododendrons that are available include: **Pink** — 'Scintillation', 'Westbury', 'Weston', 'Skyglow', 'Betty Hume', 'Warwick', 'Parker's Pink', 'Mrs. W. R. Coe', 'Wheatley', 'Pink Sparkler', 'Josephine Everitt'; **Red** — 'Acclaim', 'Avondale', 'Dorothy Russell', 'Red Velvet'; **Creamy apricot** — 'Champagne', 'Honey Dew', 'Amethyst'.

BROAD-LEAVED EVERGREENS IN THE MIDDLE WEST

Experiences at the Morton Arboretum with plants of the Heath Family

E. Lowell Kammerer and Walter E. Eickhorst

THE almost complete absence of broad-leaved evergreens in Chicago area landscape plantings, an omission especially noticeable throughout the winter months and during the late spring and early summer blooming seasons, has stimulated a growing interest in this useful class of plants. This is surprising considering the special cultural requirements known to be essential to their successful establishment and maintenance.

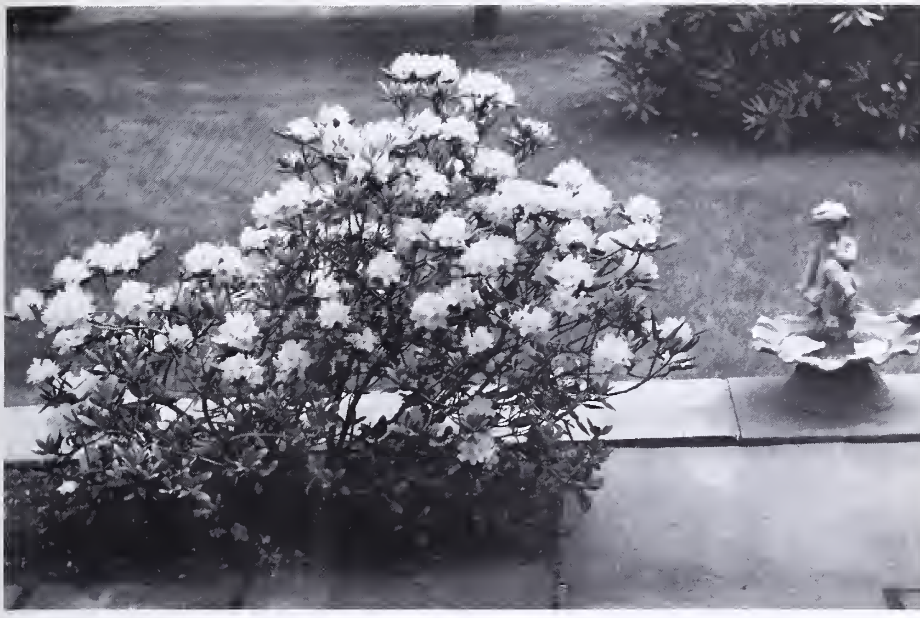
Although broad-leaved evergreens had been previously tried in numerous locations within the Arboretum grounds, the desire to see what they would do under more controlled conditions motivated the establishment of a new collection in the spring of 1951. The site chosen for the experiment was in a wooded area where topography, exposure, land and air drainage, and protection seemed to more closely approximate ideal growing conditions than any other location in which previous trials had been made. Unfortunately, the results attained at the new site failed to come up to expectations. This led to the establishment of a second experimental area in the spring of 1960. A lighter, more open location of higher elevation was selected, one providing better air drainage, natural protection from winter wind, and overhead pine shade. That these conditions were more congenial to the demands of the group has been evidenced by the more satisfactory performance of the plants involved.

Contrary to the prevailing belief, temperature extremes are not entirely responsible for the limited use of broad-leaved evergreens in the north-central states. It is more often a lack of understanding of the soil preferences of the group, the necessary pH, and in the Heath Family* in particular the symbiotic relationship existing between certain mycorrhiza (fungi) present in acid soil and the roots of the plants. Once these important facts are recognized and heeded the other prerequisites present only minor problems in comparison.

Soil

As most broad-leaved evergreens do best in a soil predominantly acid in reaction, a specially prepared mixture is necessary in limestone areas to provide a pH acceptable to them. On the "pH scale," by which soil reactions are measured, the neutral point is 7.0, with readings above denoting increasing alkalinity; those below, increasing acidity. The preferred range for the Ericaceae is between pH 4.5 and 6.0, with 5.0 representing the ideal condition. At this point the necessary iron is more readily available to the plant and the growth of beneficial mycorrhiza stimulated. We have found an ideal mixture to be one consisting of equal parts of woodland soil (top soil from oak woods), neutral sand (washed), decomposed oak leafmold and peat moss (German or Swedish). If available, oak stump (humus rotted wood from stumps or fallen logs), pine needles, or decomposed oak sawdust may be substituted for the peat. Our beds test pH 5.3. Acidity may be increased artificially by the use of ordinary sulphur, applied at a rate not exceeding 1 pound per 100 square feet per application, ammonium sulfate (one tablespoonful to 10 quarts of water), or a tannic acid solution consisting of 1 part commercial tannic acid to 50 parts of water. Aluminum sulfate, commonly recommended as a soil

*Members of the Heath Family (Ericaceae) all require an acid soil.



George Taloumis

The Carolina rhododendron (*R. carolinianum*) and its hybrids do quite well in many midwestern gardens when planted in acid soil prepared with peat moss and leafmold.

acidifier, should (if used at all) be applied cautiously in view of the fact that its continued use may cause an aluminum toxieity harmful to both roots and mycorrhiza.

Before putting in the special soil, existing soil should be removed to a depth of 2 or 2½ feet and the excavation lined with 6 inehes of cinders. Into this goes the soil mixture described above. To lessen the amount of lime leaching in from surrounding areas it is advisable to raise the planting beds above the existing grade. The einders will deter earthworms to a certain extent, although eventually they will tunnel into the aeidified soil, depositing their castings of high lime content. During drought periods the natural upward movement of ground moisture will also bring with it a certain amount of lime dissolved from the subsoil. These conditions may be overcome by confining the plantings to concrete or metal-lined pits provided with drainage outlets at the base. For small collections, disearded oil drums sawed in half and buried to within an inch or so of ground level make excellent containers, accommodating single specimens nicely.

Drainage

Poor drainage, sun, and wind are among the worst enemies of the Ericaceae and in selecting a suitable planting site for members of the family due consideration must be given all three. Our collection is located in a natural, wooded ravine sloping gradually in a north, northwesterly direction, where surface drainage is good and where a gravelly subsoil insures no standing water underground. None of the broad-leaved evergreens will tolerate soggy conditions even though they do prefer a constant moisture supply and high humidity.

Light

High overhead shade furnished by native oaks provides summer protection from bright sunlight and filtered light at other seasons. More winter shade would be desirable as a further protection against possible injury.

(Continued)

Protection

A shelterbelt of coniferous evergreens surrounding the ravine adequately meets the wind problem and may in time provide the necessary evergreen shade. In home ground plantings a shaded north or northeast exposure is desirable with further protection on the west and north. Not only will this guard against the drying effects of hot summer winds, it will lessen the chances of winter drying as well. The latter results from excessive evaporation during sunny winter days when frozen soil around the roots prevents normal replacement of the moisture lost through the leaves. A covering of evergreen branches in winter will reduce evaporation and consequent damage to plants. Spraying foliage in the fall with a plastic product such as "Wilt-Pruf" is also effective, and this procedure is being followed by many home gardeners.

A further word as to winter care. Although we have depended primarily on a covering of evergreen branches, plants of doubtful hardiness may be given added protection by encircling them with a ring of chicken wire filled with oak leaves. This ring should be 18 to 36 inches high depending upon the size of the plant.

Care

Planting may be done either during April and early May or mid-September through November, or almost any time that the soil is not frozen and the plants are not in bloom or in vigorous vegetative growth.

Most ericaceous plants are shallow-rooted and extremely sensitive to drying, so benefit by a heavy moisture-conserving mulch of oak leaves, pine needles, or peat moss kept on the year around. A covering of this type also serves to maintain acidity. Cultivation is unnecessary in fact harmful. Unless rainfall is ample and well spaced, artificial watering will be necessary throughout the summer and fall. It should be done regularly and thoroughly, before drooping foliage indicates the need. Rain water is preferable where local well water has a pH above 7, but is possible to neutralize the latter by introducing acidifying chemicals into the hose line.

Regular fertilizing with one of the standard rhododendron and azalea fertilizers in spring or early summer will help keep the plants in vigorous condition, but should iron deficiency show up in the form of yellowing foliage (chlorosis), one of the new chelated iron foliar sprays should be applied to correct the situation.

Marjorie J. Dietz

Although not a shrub, Adam's needle (*Yucca filamentosa*) is of interest in colder regions because its bold foliage remains green all winter.

The leatherleaf viburnum (*V. rhytidophyllum*) is too tender for most of the Midwest. Its rough yet attractive foliage remains in best condition in regions comparable to Philadelphia and southward.

BROAD-LEAVED EVERGREENS AT MORTON ARBORETUM, LISLE, ILLINOIS—EVALUATION OF TRIALS

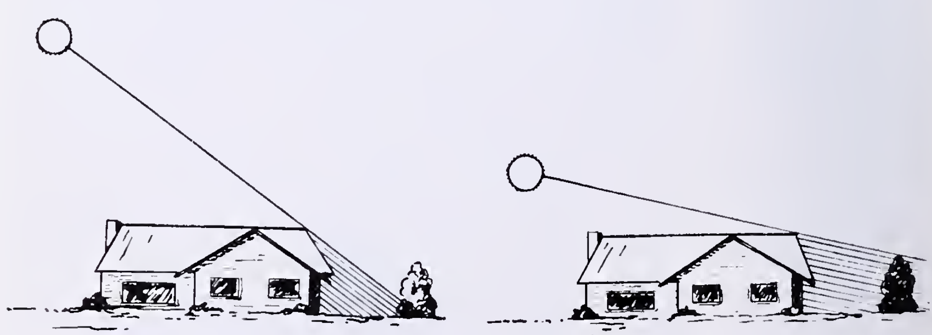
A = Prefers an acid soil
S = Satisfactory
F = Fair
P = Poor
Tr = Still on trial
* Most adaptable for trial in the Chicago area

Bearberry, *Arctostaphylos uva-ursi*	A, S
Littleleaf Boxwood, *Buxus microphylla*	S
Kingsville Dwarf Boxwood, *Buxus microphylla* 'Compacta'	F
Japanese Littleleaf Boxwood, *Buxus microphylla japonica*	F
*Korean Littleleaf Boxwood, *Buxus microphylla koreana*	S
*Glossy Winter Creeper Euonymus, *Euonymus fortunei* 'Carrieri'	S
*Purpleleaf Winter Creeper Euonymus, *Euonymus fortunei* 'Coloratus'	S
Baby Winter Creeper Euonymus, *Euonymus fortunei* 'Minimus'	S
*Common Winter Creeper Euonymus, *Euonymus fortunei radicans*	S
Whitevein Winter Creeper Euonymus, *Euonymus fortunei* 'Reticulatus'	S
*Bigleaf Winter Creeper Euonymus, *Euonymus fortunei* 'Vegetus'	S
Spreading Euonymus, *Euonymus kiautschovicus* (*patens*)	F (semi-evergreen tender)
English Ivy, *Hedera helix* (hardy varieties)	S
American Holly, *Ilex opaca*	A, S
*Bosley Hedging Holly, *Ilex opaca* 'Hedgeholly'	S
Old Heavy Berry Holly, *Ilex opaca* 'Old Heavy Berry'	S
Mountain-laurel, *Kalmia latifolia*	F, P
*Drooping Leucothoë, *Leucothoë fontanesiana*	S
Variegated Leucothoë, *Leucothoë fontanesiana* 'Rainbow'	S
Oregon Holly-grape, *Mahonia aquifolium*	F
Creeping Mahonia, *Mahonia repens*	S
Bayberry (semi-evergreen), *Myrica pensylvanica*	S
*Canby Pachistima, *Pachistima canbyi*	P, F
*Japanese Spurge, *Pachysandra terminalis*	A, S
*Mountain Pieris, *Pieris floribunda*	S
*Japanese Pieris, *Pieris japonica*	S
*Carolina Rhododendron, *Rhododendron carolinianum*	S
*Catawba Rhododendron, *Rhododendron catawbiense*	S
*Rosebay Rhododendron, *Rhododendron maximum*	S
Manchurian Rhododendron, *Rhododendron micranthum*	F

Smirnow Rhododendron, *Rhododendron smirnowii*	Tr
Rhododendron hybrids and cultivars, (For azaleas, see below)	
'Candy'	S
'Chionoides'	F, S
'County Of York'	S
fortunei #1020 and #1046 (Dexter)	S
'Ice Cube'	F, S
'Janet Blair'	S
'King Tut'	F, S
laetevirens (Wilson Rhododendron)	S
'Lavender Queen'	F
'Lodestar'	Tr, S
'Oritani'	S
'Pink Flair'	S
'P.J.M.'	S
Scintillation' (Dexter)	F, S
All varieties known as "ironclad"	S
Leatherleaf Viburnum, *Viburnum rhytidophyllum*	F (tender)
*Common Periwinkle, *Vinca minor*	S
White Periwinkle, *Vinca minor alba*	S
Purple Periwinkle, *Vinca minor atropurpurea*	S
Bart's Bigleaf Periwinkle, *Vinca minor* 'Bart's Bigleaf'	P
*Bowles Periwinkle, *Vinca minor* 'Bowles'	P
*Adam's-needle Yucca, *Yucca filamentosa*	S

Azaleas. Here is a list of *deciduous* kinds which have proven satisfactory at the Morton Arboretum:

Pontic Azalea, *Rhododendron flavum*
Japanese Azalea, *Rhododendron japonicum*
Korean Rhododendron, *Rhododendron mucronulatum*
Royal Azalea, *Rhododendron schlippenbachii*
Pinxterbloom Azalea, *Rhododendron nudiflorum*
Azalea 'Sham's Yellow'
Azalea 'Smoky Mountaineer'
Korean Yodogawa Azalea, *Rhododendron yedoense poukhanense*
Exbury hybrids
Ghent hybrids
Ilam hybrids (some still under trial)



HOW TO PROTECT A HOLLY FROM WINTER SUN Place holly (American and English) on north side of house where it receives needed sunlight in summer when sun is high. In winter the tree is protected from low winter sun by shadow of house. Too much winter sunshine as well as wind can contribute to burning of the foliage.

Even where low winter temperatures are the rule, some kinds can be grown

BROAD-LEAVED EVERGREENS IN THE UPPER MIDWEST

Leon C. Snyder

EXPOSED prairie conditions of the central "just-below-Canada" states are known not to be favorable to the growing of broad-leaved evergreens. Nonetheless, a measure of success can be expected if plants are grown in semi-wooded areas in medium acid soils. (For creating acid soils in the Middle West, see page 66.)

The insulating snow cover, usually present from Thanksgiving to April, helps insure the winter welfare of broad-leaved evergreens in this region. Temperatures of —20° to —50° F. may have little or no damaging effect on snow-covered plants of recognized hardiness. Occasionally, when snowfall is early, the ground beneath does not freeze at all!

Protection from winter sun and wind is of major importance to the success of broad-leaved evergreens in this region. One way of achieving this protection is by planting in the shade of coniferous trees, the north side of buildings or by the use of artificial shade such as burlap. Avoid planting where wind sweeps around the corners of buildings. For low, creeping evergreen ground covers, planting where there is dependable snow cover is perhaps the best means of protecting against winter injury.

Hardy Broad-Leaved Evergreens

Andromeda (*Andromeda polifolia*)
Bearberry (*Arctostaphylos uva-ursi*)
Wintergreen (*Gaultheria procumbens*)
Bog-laurel (*Kalmia polifolia*)
Labrador-tea (*Ledum groenlandicum*)
Leatherleaf (*Chamaedaphne calyculata*)

Reasonably Hardy Kinds

(when grown in sheltered locations and with proper winter protection)

Korean Boxwood (*Buxus microphylla koreana*)
Garland Flower (*Daphne cneorum*)
Winter Creeper (*Euonymus fortunei*) Creeping forms only. 'Coloratus' probably the hardiest.
Creeping Holly-grape (*Mahonia repens*)
Japanese Spurge (*Pachysandra terminalis*)
Canby Pachistima (*Pachistima canbyi*)
Carolina Rhododendron (*Rhododendron carolinianum*) 'PJM'. This hybrid of *R. carolinianum* is hardier than the species.
Catawba Rhododendron (*Rhododendron catawbiense*) and cultivars.

Marjorie J. Dietz

The true andromeda (*Andromeda polifolia*), a small shrub, has narrow gray leaves and showy white or pink flowers in spring.

Rosebay Rhododendron (*Rhododendron maximum*)
Periwinkle or Myrtle (*Vinca minor*)

Semi-evergreen Shrubs

Turkestan Dwarf Euonymus (*Euonymus nanus* 'Turkestanicus'
Bayberry (*Myrica pensylvanica*)
Wineleaf Potentilla (*Potentilla tridentata*)

***Non-hardy Species**

Japanese Holly (*Ilex crenata*)
Inkberry (*Ilex glabra*)
American Holly (*Ilex opaca*)
Mountain-laurel (*Kalmia latifolia*)
Drooping Leucothoë (*Leucothoë fontanesiana*)
Laland Firethorn (*Pyracantha coccinea* 'Lalandei')

*Generally unsuccessful in our area.

Marjorie J. Dietz

Rhododendron 'PJM' is proving to be hardy in many regions with severe winters.

George Taloumis

(1) Catawba rhododendron and its hybrids, (2) Japanese spurge (*Pachysandra terminalis*), (3) *Pachistima canbyi* and (4) periwinkle or myrtle (*Vinca minor*) are considered reasonably hardy in some regions of the upper Midwest.

BROAD-LEAVED EVERGREENS FOR SOUTHERN CALIFORNIA

and similar semitropical regions

George H. Spalding and Donald P. Woolley

Palms

Mediterranean Palm (*Chamaerops humilis*)
Canary Date (*Phoenix canariensis*)
Senegal Date (*Phoenix reclinata*)
Fortune's Windmill Palm (*Trachycarpus fortunei*)
California Washington Palm (*Washingtonia filifera*)
Mexican Washington Palm (*Washingtonia robusta*)

Trees

*Weeping Boree Acacia (*Acacia pendula*)
*Cootamundra Wattle (*Acacia baileyana*)
(There are too many other species of Acacia valuable as ornamentals to be listed here.)
Carrotwood (*Copaniopsis anacarpioides*)
Rusty Gum-myrtle (*Angophora lanceolata*)
*Camphor Tree (*Cinnamomum camphora*)
Citrus varieties
Loquat (*Eriobotrya japonica*)
Eucalyptus, many species including
Lemon Eucalyptus (*Eucalyptus citriodora*)
Scarlet Eucalyptus (*Eucalyptus ficifolia*)
Coolgardie Coral Eucalyptus (*Eucalyptus torquata*)
Moreton Bay Fig (*Ficus macrophylla*)
**India-laurel Fig (*Ficus nitida*)
Australian-willow (*Geijera parviflora*)
Sweetshade (*Hymenosporum flavum*)
Chinese Fan Palm (*Livistona chinensis*)
Southern Magnolia (*Magnolia grandiflora*)
Olive (*Olea europaea*)
Diamondleaf Pittosporum (*Pittosporum rhombifolium*)
*Orange-berry Pittosporum (*Pittosporum undulatum*)
Carolina Cherry-laurel (*Prunus caroliniana*)
Holly Oak (*Quercus ilex*)
*California Pepper-tree (*Schinus molle*)
Brazil Pepper-tree (*Schinus terebinthifolius*)

Shrubs

Glossy Abelia (*Abelia grandiflora*)
*Broadleaf Acacia (*Acacia latifolia*)
*Strawberry-tree (*Arbutus unedo*)
Japanese Aucuba (*Aucuba japonica*)
Azalea—Indica hybrids
Camellia—in variety
**Natal-plum(*Carissa grandiflora*)
*Ceanothus (*Ceanothus* spp.)
Rock-rose (*Cistus* spp.—particularly *ladaniferus, laurifolius,* and *purpureus*)
Cotoneaster lactea (*parneyi*)
**Dombeya (*Dombeya dregeana*)
Montevideo Escallonia (*Escallonia montevidensis*)
*Seaurchin Hakea (*Hakea laurina*)
Burford Chinese Holly (*Ilex cornuta* 'Burfordii')
Bay-laurel (*Laurus nobilis*)
Glossy Privet (*Ligustrum lucidum*)
True Myrtle (*Myrtus communis*)
*Oleander (*Nerium oleander*)
Sweet Osmanthus (*Osmanthus fragrans*)
Chinese Photinia (*Photinia serrulata*)
Tobira Pittosporum (*Pittosporum tobira*)
*Firethorn (*Pyracantha* hort. varieties)
Roundleaf Yeddo Raphiolepis (*Raphiolepis umbellata ovata*)
Japanese Viburnum (*Viburnum japonicum*)
Sandankwa Viburnum (*Viburnum suspensum*)

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*Withstands drought better than others.
**May be slightly damaged by frost in colder areas.

PROPAGATING BROAD-LEAVED EVERGREENS

A simplified method based on experiences at the Holden Arboretum and elsewhere

Lewis F. Lipp

PROPAGATION by cuttings of the broad-leaved evergreens, using a combination of hormone powder, peat moss, sand, and granular styrofoam or perlite (a foamed plastic) for the rooting medium, plus a polyethylene plastic tent for covering a flat or box, has now simplified the way of increasing many formerly hard-to-root evergreens. Included are rhododendrons and evergreen azaleas, hollies, mountain-laurel and bearberry.

To make the propagating unit, a greenhouse flat, preferably a deep one, is filled with a mixture of 70 per cent peat moss, 10 per cent sharp clean sand, and 20 per cent granular styrofoam. Cuttings, made and treated as directed below, are set in this and watered well. Next a wire frame is put over the flat to serve as a support for the polyethylene film. Before putting on the film, a layer of damp cheesecloth may be spread over the frame. Over this is placed a sheet of polyethylene plastic large enough to tuck under the sides, ends, and bottom of the flat. The plastic checks loss of water, yet permits change of air; the cheesecloth distributes the moisture more evenly in the tent and gives a little shade for the cuttings.

After cuttings are planted the propagation unit can be placed on a bench in a greenhouse or in the window of a dwelling. In spring and summer it can be placed out-of-doors under a tree. If well sealed, the unit need not be watered for weeks or even months. In a window or greenhouse it should be shaded from direct sun in hot weather.

American Holly

Many individuals, having a deep-rooted affection for the broad-leaved evergreens, have wisely selected the various evergreen hollies as ornamental plants for their property. Today there are a phenomenal number of named cultivars of American holly *(Ilex opaca)* being grown. The majority of these do not deserve variety names because they are not sufficiently different from others; none the less, some outstanding varieties are available which are suitable for almost any environment with the exception of the high altitude areas where the winters are especially severe. After close examination, I would select 'Cumberland' and 'Red Velvet' as the two best female plants, and 'David' the most conspicuous male plant in the Holden Arboretum's collection of American hollies. Cuttings of these hollies, as well as of other named cultivars of *I. opaca,* can be readily rooted beginning the middle of August. In other words, the cuttings are taken when the current year's growth becomes dark green. Cuttings 4 to 6 inches in length are taken from the ends of the branches. Only three leaves are left on each one. Heavily wounding the cuttings is a generally accepted practice. Draw a sharp knife down the side of the stem at the base for a distance of about 2 inches. Cut only deeply enough to expose the thin, soft, slippery layer (cambium) which lies just under the bark. By treating this exposed, wounded surface with Hormodin #3, faster rooting will take place. These cuttings will take roughly 8 weeks to root, about 2 weeks longer than those of English holly.

Growing Holly from Seed

Although seeds of American and English holly can be collected or purchased they can not be recommended for the amateur. Even freshly gathered seeds, cleaned of

their pulp, usually require up to 2 years to germinate. Hollies have separate male and female plants and only the latter produce berries. When raised from seed there is no assurance of the sex of the plants. Moreover, hollies do not "come true," and thus the shape of the leaves, or size and color of the berries will be variable and not necessarily resemble the parent plants from which the seeds are collected.

For those who wish to try growing these hollies from seed despite the difficulties, the best procedure is to stratify them. The seeds are removed from ripe berries and cleaned. They are then mixed with moist peat, placed in a closed jar or deep-freeze bag, and placed in a refrigerator for one year. They should then be planted in a sand-peat moss mixture. Some varieties may germinate in a shorter time, so it is wise to examine the seed in the refrigerator containers from time to time. If some seeds show signs of germinating, take out and plant. Another method of stratifying is to place the mixture of seeds and peat moss in a tin can or other metal container in which are punched a few small holes. This is buried 6 to 8 inches deep in garden soil. After a year the seeds are taken up and planted as usual in beds or flats. Seedlings from such a planting may continue to appear over a period of 3 years.

Japanese Holly

In recent years, a number of named cultivars of Japanese holly (*I. crenata*) have been developed in the eastern section of the United States. One reason for introducing these new cultivars is that the well-known variety *I. crenata* 'Convexa' has become increasingly subject to the red mite, which turns its attractive glossy, convex leaves into a sickly foliage. Among the many miticides which have been developed, malathion gives excellent control. A comparatively new cultivar, *I. crenata 'Hetzii'*, is slowly finding its way into catalogues. For certain uses this type is superior to the usual 'Convexa'. Its leaves are much larger and

1 Cuttings of evergreen azaleas and other shrubs can be taken in early summer.

2 They are inserted in nursery flats filled with moist peat moss and sand.

Marjorie J. Dietz

3 After thorough watering, flats are enclosed in plastic film stretched over wire frames.

less apt to be disfigured by insects. This new introduction appears to be every bit as hardy as the original variety and develops into an attractive plant in one-third the growing time. One of the dwarf Japanese hollies that has escaped attention is the slow-growing *I. crenata* 'Mariesii'. This plant makes a thicket of short twigs densely crowded with circular leaves. In making cuttings, whether of this pygmy form or any other variety of Japanese holly, take 3- to 6-inch stem cuttings from the plants during the early fall, removing the lower leaves. These cuttings will root exceedingly well without hormone powder when placed under a plastic tent.

Unlike the seeds of American and English hollies, those of Japanese holly do not have to be stratified if they are properly matured and cleaned of their pulp. They should be sown in a mixture of sand and peat, and will produce a high percentage of seedlings in a reasonable time. In attempting to grow *Ilex crenata* cultivars from seed it will be discovered that the seedlings vary from the parents, some being desirable, some undesirable.

Growing Rhododendron from Seed

Growing rhododendrons from cuttings is possible under plastic but is slow. Azaleas are easier. The recommended practice for raising both from seed is to sow the dust-like seeds thinly on German or Dutch peat in February. Ground sphagnum can be used instead of the peat. After sowing, the seeds are watered with a fine mist or spray; under no circumstances should a forceful jet of water be used. It is beneficial to cover the flat with a sheet of plastic to maintain a moist atmosphere over the planted seeds. As soon as the seedlings appear, the plastic cover should be removed and the flat placed where the seedlings will get plenty of light and where there is good air circulation. Small plantings may be made in plastic refrigerator boxes. After the seedlings appear the covers are removed from the boxes and the same procedure as with plantings in flats is followed. When the seedlings are large enough to be handled they can be pricked out into flats containing a mixture of sand, soil, and peat moss. The seedlings grow well under fluorescent light fixtures.

Mountain-laurel

To many people the most beautiful of all flowering shrubs is mountain-laurel (*Kalmia latifolia*). Its numerous large clusters of small, saucer-shaped, rose-colored flowers against the deep green glossy foliage are a familiar sight in June in some regions. A conspicuous variety is *K. latifolia* 'Rubra', which has deep red buds opening to a deep pink. The most unusual variety to date is *fuscata,* with a broad, dark purplish band inside the corolla. Nurserymen are discovering that these scarce varieties of *Kalmia* can now be readily propagated under plastic covering. This opportunity is available to the home propagator as well. Cuttings 2 to 3 inches long of current year's wood should be taken from the tips of the branches during early August. Treated with 1 per cent indolebutyric acid, these cuttings should strike root within 3 months. Mountain-laurel seeds should be sown according to directions for rhododendron seed.

Pieris

The last few years have seen a marked increase in the use of broad-leaved evergreens in Ohio and neighboring states. Perhaps it is due to the blight which attacks the old favorite *Pieris floribunda* that *P. japonica* is now being grown in this part of the country. This shrub, seldom more than 5 feet high, has brilliantly colored new foliage and pendulous racemes of lily-of-the-valley type, waxy white flowers during April. There is also a variegated form that is much slower in growth. In taking cuttings of either *Pieris floribunda* or *P. japonica,* use the short side shoots during August and September. Treating them with Hormodin #3 should give a good return of rooted cuttings in 10 weeks. Seeds of pieris should also be handled as recommended for rhodendrons.

Another method of increase

MIST PROPAGATION

Conrad B. Link

MIST PROPAGATION has been found most useful in the propagation of softwood cuttings and evergreens, especially the broadleaf types. A few of the kinds that the home gardener will want to use in an outdoor bed or in the home greenhouse are mentioned below.

Azalea. The evergreen types, represented by such variety groups as Kurume, Kaempferi, Glenn Dale, Chugai, Gable and others, generally are propagated outdoors in mid- to late-summer (July and August in north temperate climates). By this season the new growth has matured sufficiently for good rooting to occur, *i.e.*, firm greenwood will root more quickly than if more mature. Cuttings should be 3 to 4 inches long. The lower leaf or two should be removed and the cuttings inserted in the propagating medium. Use one of the root-promoting powders and, after insertion in the medium, water the cuttings thoroughly and begin the misting operation. After the cuttings have rooted (4, 6 or 8 weeks depending on the kind, and season of the year) they are potted or transplanted. Cuttings taken later in the season may be left outdoors in the propagating bed after rooting until they are transplanted in the spring. If this latter practice is followed, it is well to use a medium that contains some organic matter such as peat, at ⅓ to ½ by volume. Reduce the frequency of misting as rooting occurs and then, later, before freezing weather, mulch the rooted cuttings and provide some winter protection. The medium must be moist and not allowed to dry out.

Boxwood. Cuttings of boxwood *(Buxus)* can be made at the same season as azaleas and should receive the same treatment. Cuttings may be small single stems, 2 to 3 inches long or they may be longer branched cuttings. With greenhouse facilities available, boxwood may be propagated at any time of year, except during the period of rapid growth in May and June.

Pieris. *Pieris japonica* (commonly called "Andromeda") may easily be rooted from cuttings and is given essentially the same care as azaleas. Cuttings generally are made 4 to 5 inches long, using the strongest shoots. If outdoors, late summer is the best season; during the winter if in a greenhouse.

Holly. Hollies *(Ilex),* the named cultivars in particular, are propagated by cuttings. Cuttings of American holly are taken in late summer, using tips of well-matured shoots, 4 to 6 inches long. Root-promoting substances should be used. The best rooting medium is a mixture of equal parts of sand and peat moss. If this is used in outdoor beds, the cuttings may be left in the bed over winter. The use of mist is helpful just after the cuttings have been made but it less necessary after the first several weeks, and as the weather becomes cooler. Japanese hollies root readily. Outdoor cuttings may be taken in late summer but where a greenhouse is available, cuttings of both American and Japanese hollies may be taken through the early winter months. If the Japanese cuttings are soft, they may be treated much as softwood cuttings and will require frequent misting. However, if they are more mature and are being propagated under rather cool conditions in an outdoor frame, misting should be less frequent.

The use of mist does not change other practices or attention that are necessary to successful propagation, such as proper temperature and light. Cuttings should be selected carefully, and root-promoting compounds used to speed time of rooting, often with increases in percentage of cuttings that root.

(Continued)

Marjorie J. Dietz

Japanese skimmia (*Skimmia japonica*) is easily propagated from cuttings or layers. Cuttings will even form roots in water.

Types of Equipment

The use of automatically operated misting or humidifying systems, has greatly simplified propagation of cuttings, whether softwood, broad-leaved evergreens, herbaceous perennials or annuals. Several types of equipment and systems have been developed. Humidifying devices that blow finely misted water into the air are useful in greenhouses or enclosed chambers, but are not adaptable to large outdoor areas and are even somewhat restricted when used in a greenhouse. Mist systems that will spray a mist or dense fog over the cuttings are more adaptable, particularly if they can operate at available water pressures. Such systems may be regulated to operate continuously or, as is generally adequate, to operate during daylight hours. Some types use a control clock (with timing device) which puts the system into operation and regulates the sequence of misting. It is usually turned on for a few seconds and then off for one to several minutes and then on again. Other mist regulators are designed to operate when the water is evaporated from a screen or small metal plate to simulate loss of water from a leaf.* When the water evaporates from such a surface, the mist is turned on for a short time until the screen is wet again and the system is turned off.

*At Brooklyn Botanic Garden we use the Mist-A-Matic (Geigy) System, with ¼ in. pipe thread nozzle and stainless steel tip. A time clock provides flexibility to timing of misting.

Many kinds of nozzles have been used but whatever the selection, it should be capable of distributing a fine mist uniformly over the area of the cuttings. Those that produce a coarse mist may actually be used to "water in" the cuttings after they have been inserted in the propagating medium. A strainer should always be installed in the water line to reduce clogging of nozzles, even if regular tap water is used.

For the home propagator, the system that operates on regular water pressure with an inexpensive time clock and timing device is the most practical.

In practice, the interval of misting is longest when cuttings are first placed in the propagating medium; then later, as roots begin to form, the interval of misting may be reduced gradually until the cuttings are ready for potting or planting.

The propagating medium and general setup are no different from general propagation methods. It is essential, since there is more water being used than in conventional methods, that there be good drainage from the propagation bed or box and that the medium be well drained and well aerated. Propagators wishing to use peat as a propagating medium may use wire screen for the bottom of the bed to insure this drainage. With mist propagation, however, it is not necessary to incorporate peat moss into the medium. Sand, perlite, vermiculite or inert mineral materials may be used alone.

In mist propagation, the foliage is kept moist at all times, so there is little loss of water by transpiration or drying out. This makes it possible to root cuttings in a higher light intensity. In fact, many species and cultivars can be rooted in full light, or full sunlight out-of-doors. This opportunity of rooting in higher light intensity means that the leaf continues its photosynthetic function more efficiently, and rooting takes place more quickly.

If a mist system is installed out-of-doors, some kind of screen or shield should be placed around it so the wind will not interfere with uniform distribution of mist over the cuttings.

BOOKS FOR FURTHER READING

Frederick McGourty, Jr.

THERE are a number of excellent books on broad-leaved evergreens. The following list should be of special interest to readers who would like to know more about the subject. Also, please see the suggestions for further reading in *Rhododendrons and Their Relatives,* Handbook #66 in the Brooklyn Botanic Garden series.

Frederick P. Lee's *The Azalea Book* (New York: Van Nostrand-Reinhold, 2nd edition, 1965) is the standard reference on this subject. Readers will also find much useful information in Clement Gray Bower's *Rhododendrons and Azaleas* (New York: Macmillan Co., 2nd edition, 1960) and H. Harold Hume's concise, out-of-print volume, *Azaleas and Camellias* (New York: Macmillan Co., 1953).

Hume's interest in broad-leaved evergreens was widespread, and his *Camellias in America* (Harrisburg, Pennsylvania: J. Horace McFarland Co., revised edition, 1955), though out-of-print, contains a mine of information. It is worth seeking out in a horticultural library. Still available is his book on *Hollies* (New York: Macmillan Co., 1953).

Although heather has been grown in America since Colonial times with a fair degree of success, it doesn't seem to have caught the fancy of garden writers here. A rather recent book from England is Terry L. Underhill's *Heaths and Heathers* (Newton Abbot: David & Charles, 1971). It gives background, but one must remember that varieties (many of which are not available here) thriving in England do not necessarily prosper on this side of the Atlantic.

David G. Leach's monumental tome *Rhododendrons of the World* (New York: Scribner's, 1961) gains new readers each year. It is one to which the true rhododendron buff ultimately turns. Two more recent books of note are Gerd Krussman's *Rhododendrons, Their History, Geographical Distribution, Hybridization and Culture* (translated from German; New York: Drake Publishers, Ltd., 1970) and *Dwarf Rhododendrons* by Peter A. Cox (New York: Macmillan Co., 1973).

Please note that several of the societies whose addresses are given inside the back cover have published guides for new gardeners and hobbyists. One of the best of recent vintage is George Morgan's *The Camellia: Its Culture for Beginners* (1971), available from the Camellia Society.

Handbook of Hollies (1970) is the most comprehensive, up-to-date work for the hobbyist, and *Holly in U.S.A.* (1972), Holly Society of America Bulletin #12, is also a useful reference. For the professional or advanced grower of American holly, there is the *International Checklist of Cultivated Ilex, Part I* (1972), available from the National Arboretum, Washington, D. C. 20002.

Rhododendron Information (1967), published by the American Rhododendron Society, includes azaleas, too. There are descriptions and ratings of various kinds as well as a section on care and culture.

Also, the U. S. Department of Agriculture has introductory pamphlets on growing azaleas and rhododendrons, boxwoods, camellias, hollies and magnolias. These are in the "Home and Garden Bulletin" series. *A List of Available Publications* from the U.S.D.A. is to be had by remitting 45¢ to the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

Several general reference works should also be noted. Donald Wyman's *Trees for American Gardens* (New York: Macmillan Co., revised edition, 1965) and *Shrubs and Vines for American Gardens* (same publisher, 1969) are often consulted by gardeners. *Plant Propagation* by Hudson T. Hartmann and Dale E. Kester (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 2nd edition, 1968) is a detailed, practical textbook.

Living connection with the past

THE UNIQUE BOX HUCKLEBERRY

J. W. Adams

SURPRISINGLY few people are aware of the existence of two biological wonders in Pennsylvania. They are isolated colonies of box huckleberry (*Gaylussacia brachycera*) growing 9 miles apart in the central part of the State.

Old Colonies

While this species has been known since about 1790, it was not until 1845 that a colony, 8 acres in extent, was discovered near New Bloomfield by Spencer F. Baird, who later became the Secretary of the Smithsonian Institution. For years this discovery did not arouse any particular attention; but in 1918 Dr. Frederick V. Coville of the United States Department of Agriculture, after extensive studies, announced that this colony actually consisted of a single plant, and that it had started as a seedling at least 1,200 years ago. It might be still older, since it may well have covered an even greater area in pre-settler days.

This news caused plant enthusiasts to realize that here was a priceless treasure which needed protection. Finally, through the interest stirred up, the colony was set aside as a State preserve under the Pennsylvania Department of Forests and Waters. In July, 1968, the Pennsylvania Department of Forests and Waters, now called Department of Environmental Resources, and the National Park Service dedicated the plant as a National Historical Monument.

In 1920 Harvey A. Ward, Secretary of the Harrisburg Natural History Society, accompanying a fossil-hunting group along the Juniata River opposite Losh Run, wandered off in search of living plants. Suddenly he came upon what turned out to be a most notable botanical discovery—a second colony of this species in Pennsylvania, even greater in area than the first.

Dr. Coville and Dr. Edgar T. Wherry were notified, and they came from Washington, D. C., to investigate. Measurements and studies showed that like the previous colony, this also consisted of a single individual. However, this one covered a distance of 1¼ miles along a northern slope east of the river, and was estimated to be 13,000 years old.

It seemed almost unbelievable that here was a plant already ancient even before the seeds of our present Redwoods of California had germinated, unquestionably the oldest thing alive on this earth. Awed by such a thought, some felt that the fate of this individual should not be in the hands of a single person, group, or generation. The suggestion was made that perpetual protection be given this old plant so that it might continue to live for many centuries to come. A promise was made by the Department of Environmental Resources that it would try to set aside this colony also as a preserve. So far this has not been done. Colonies are now known to occur in Pennsylvania, Delaware, Maryland, Virginia, West Virginia, Kentucky, and Tennessee. Several of these, also, are very old.

Viewing this species, the visitor sees an expanse of low carpet of dark green, slightly less than 2 feet deep, covering the acid soil of the woods. In spring, numerous pinkish flower clusters stand out against the foliage. These are followed by an abundance of bloomy, light blue fruit. Each colony spreads by underground runners, the average growth of which is 6 inches a year. (This fact, together with the area occupied, is the key for determining the ages of the plants.) Often a decayed fallen oak stump or trunk is completely covered by runners to form a mound of denser, richer green than the rest. One can readily see how the superficial resemblance to boxwood

suggested the common name (box huckleberry) for this evergreen. In late fall and winter the entire colony is tinged a beautiful bronzy hue.

With permission of the State, several experimental transplantings were made, about 1939, to Bowman's Hill State Wild Flower Preserve in Bucks County, Pennsylvania. Today these plants have grown into beautiful specimens. Nursery-grown cuttings do well and indicate that this mode of propagation is an excellent way of developing vigorous plants. Cuttings from soft wood taken in summer root best. Use a rooting medium of peat moss and sand, and cover the flats of cuttings with polyethylene film, to keep the humidity more or less constant (see page 80). Like other members of the Heath Family, the box huckleberry must have a highly acid soil.

PLANT SOCIETIES

Sooner or later the keen grower of broad-leaved evergreens turns to the specialized societies for additional information on various plant groups. Most societies, which are membership organizations, publish regular periodicals, yearbooks or manuals of some sort, and some of them have seed exchange lists. Here is a list of the most pertinent societies:

The American Boxwood Society (Box 85, Boyce, Virginia 22620) publishes a quarterly, *The Boxwood Bulletin*. The annual dues are $5.00.

The American Camellia Society (Box 212, Fort Valley, Georgia 31030) prints a yearbook as well as a quarterly, *The Camellia Journal*. It also has a 34-page guidebook (1971) for the beginner. The Society conducts a 7-acre demonstration garden in Fort Valley. Dues $7.50.

The American Magnolia Society issues a quarterly newsletter for its members. Dues are $5.00 and should be sent to the Treasurer, Philip J. Savage, Jr., 2150 Woodward Ave., Bloomfield Hills, Michigan 48013.

Information on the American Rhododendron Society may be obtained from Bernice J. Lamb, Executive Secretary, 2232 N. E. 78th Ave., Portland, Oregon 97213. A quarterly bulletin is sent to members. The Society also issues a grower's guide which is revised periodically. Dues $10.00.

The American Rock Garden Society covers the field but its quarterly bulletin often has articles for the broadleaved evergreen hobbyist. The Secretary is Milton S. Mulloy, 90 Pierpont Rd., Waterbury, Connecticut 06705. Dues $5.00.

The Holly Society of America (Bluett C. Green, Jr., Secretary-Treasurer, 407 Fountain Green Rd., Bel Air, Maryland 21014) publishes a newsletter several times a year and has a "Handbook on Hollies" (1970). Dues $5.00.

The Palm Society (Mrs. T. C. Buhler, Executive Secretary, 1320 S. Venetian Way, Miami, Florida 33139) issues a quarterly, *Principes*. Dues $6.00.

Finally, readers especially interested in heaths and heather may turn to The Heather Society, which publishes a yearbook and three bulletins each year. The Treasurer is E. R. Turner, Filma Dene, Burstow, Surrey, England. Dues are $5.00, or £1.55 sterling.

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BROOKLYN BOTANIC GARDEN RECORD

Plants & Gardens

The Year's Highlights in Gardening and Horticulture

Recent Nontechnical Books and Articles for Gardeners

WINTER 1973-74

VOL. 29 No. 4

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Copies of special issues of PLANTS & GARDENS are available as Handbooks. For a list of topics see back cover.

David Cooper

Herb Clement/Mike Calle

The Japanese hill-and-pond garden at the Brooklyn Botanic Garden is the abode of—among many things—several kinds of turtles (see page 38). The most spectacular residents are several eastern spiny softshell turtles. One is shown (*right*) basking on the pond's surface.

LETTER FROM THE BROOKLYN BOTANIC GARDEN

In horticulture as in other areas, 1974 is shaping up quite differently from 1973. Some gardeners are having second thoughts about purchasing the extra power lawnmower or other energy-consuming equipment, and the fuel shortage is affecting the home greenhouse. Lean supplies are occurring in commercial fertilizers, plastic pots, pine bark mulch and, as everyone knows, in paper, which even delayed the appearance of several recent PLANTS & GARDENS.

Prices are rising partly because of the shortages, too. Lawn seed costs twice as much as a year ago, and the gardener in search of quality nursery stock can expect to pay more this year than in the past. Yet, horticulture is more fortunate than other fields. After all, it is basically the tilling of the soil, and we turn to it for both sustenance and reassurance when the times are uncertain. Many people are now beginning to take Voltaire's dictum literally as well as figuratively: cultivate thine own garden.

Plants, it might be said, have always been undervalued in terms of the enjoyment they bring over the years. And the pleasure of growing one's own vegetables for the table probably outweighs the financial savings for most people, although the thought of economy may spark the initial interest of the new plantsman. In any event gardening, whether it takes place in the backyard or on the apartment window-sill, is booming these days, and for this no one can be sad.

The winter issue provides an opportunity to take stock of the previous year's gardening literature, too. Included here are some articles of timely (or timeless) interest that have appeared in other publications, also a few that are seeing print for the first time. Among the latter, it is a special pleasure to note that four are by graduate students in horticulture at different universities around the country. At least one other Contributor is in her early 20's. The encouragement of promising young people in this field is something the Botanic Garden has always considered one of its most welcome tasks.

To all Contributors—old troupers and young—a warm word of appreciation for making this issue come to life. Also, let us at this time thank the periodicals which have given us permission to reprint certain articles. Their friendly cooperation is a reminder that PLANTS & GARDENS, while published by the Brooklyn Botanic Garden, is a continuing trust on the part of the broader horticultural community.

A word about Dr. George S. Avery, P&G's founder—and director of the Garden for a quarter-century until his semi-retirement several years ago. It is a pleasant duty to report to all of our readers that he is the current recipient of the Veitch Memorial Medal of the Royal Horticultural Society. It is awarded "to those who have helped in the advancement and improvement of science and the practice of horticulture." Mr. H. G. Hillier, the noted English nurseryman, has accepted the medal on Dr. Avrey's behalf.

A new year of cultivation is starting in most parts of the country now, and with it hope is renewed. May the crabapple flower more heavily than last year, the asparagus grow plumper, and the gardenia thrive as it never has before. Good gardening!

Frederick McGourty, Jr.

Editor

Use knowledge of house plant culture to embark on the adventure of starting a small indoor bonsai collection

INDOOR BONSAI

From Plants Alive, May, 1973

Elizabeth Scholtz

There are a number of devoted growers of house plants who might like to expand their horizons and grow house plant bonsai, if they knew how simply it can be done.

The word "bonsai" literally translated means "tray planting." The "tray" is a ceramic container with small "feet"; the "planting," one or many small trees or shrubs grown in the container. It is important to think of the plant and container together, for in the making of bonsai the whole is greater than the sum of the parts. Bonsai is a work of living art.

House plants, however well grown, may often be just shapeless masses of foliage sometimes topped with flowers, growing in clay pots or plastic containers of doubtful charm.

The work one puts into keeping house plants healthy and attractive will also result in fine indoor bonsai, once the initial pruning and training is done and subsequent pruning is understood. The pruning and training techniques are the same as for hardy outdoor bonsai. The difference lies in the choice of plants to be trained.

City dwellers, particularly those who have little or no outdoor growing space, have had to change their ideas about the finest candidates for bonsai treatment. The classic pines, spruces, maples and larches do not respond favorably to house plant culture. It is to the tropics and semitropics that we must turn for most house plant bonsai, and there are numerous trees and shrubs of warmer climes that lend themselves to bonsai training. Among these are several species of citrus, gardenia (particularly the small-leafed *Gardenia radicans*), dwarf pomegranate (*Punica granatum nana*), Natal-plum (*Carissa grandiflora*), rosemary (*Rosmarinus officinalis*) and many others.

The criteria for choosing plants for training as bonsai are small leaves, small flowers and fruits (if present) and a tapering trunk and interesting bark. Many woody plants display these characteristics and the aspiring bonsai grower is advised to look for such a tree or shrub in a garden center. Of course, it may be grown from seed and trained from the start if one has the patience.

Containers for indoor bonsai call for careful selection of authentic Japanese styles. The "tray" is as important as the plant, and should be the perfect complement to the dwarfed tree it is to contain. Size, shape, depth and glaze color are all to be considered. Glazed containers are usually used indoors because the earthen-colored pots tend to look drab, particularly when growing flowering varieties. It is important that containers are *not* glazed inside and that they have one or more drainage holes.

A few words of caution about soil: Soil that drains well is of paramount importance for bonsai culture. If a soil tends to be clayey and tight, the addition of sand or perlite is advised. After placing a metal or plastic screen over the holes, be sure to have an adequate layer of washed, small-textured gravel (e.g., bird gravel) underneath the soil. This provides aeration for roots and augments drainage.

As to watering practices: A good rule of thumb is to water whenever the soil feels dry. This may mean several times a day if shallow containers are kept in a dry room. One way of lightening the burden of watering is to keep one's bonsai on trays of moist pebbles. If the pebble-containing tray is half-filled with

Photographs by Arthur Norman Orans

This *Cotoneaster microphylla* 'Cochleata' has been trained as a cascade. It is ten years old.

A six-year-old plant of *Carissa grandiflora* that is in process of being trained as a cascade.

water, it will help create a moist microclimate around the plants. Another way of achieving a more humid atmosphere is to improvise a miniature greenhouse by keeping one's bonsai on a wide window-sill separated from the dry room by a clear plastic curtain. Miniature plastic greenhouses are also available for purchase or can be constructed simply in the home. If it is necessary to leave plants unwatered for a few days they can be enclosed in plastic bags, but while inside their plastic enclosure they should never be exposed to the direct rays of the sun as they will literally cook under such conditions. Bright light but no direct sun is desirable.

It is possible to grow plants under artificial light quite successfully, and for most plants 14 to 16 hours of light is optimal—less light when the plants are not growing rapidly. There are many types of fluorescent light fixtures, some of which may be obtained from mail order firms. These lights supply the answer for would-be growers living in dark city apartments.

Fertilizing is important if the plant is to grow rapidly—and well-fed tropical plants grow much faster than others. A good low-nitrogen house plant fertilizer should be used every three or four weeks in spring and summer. Fish emulsion is our favorite fertilizer for the Brooklyn Botanic Garden bonsai collection and may be used in place of chemical fertilizers. When the plants are growing actively they should be kept pinched back, *i.e.*, long shoot tips should be removed with thumb and forefinger while still soft. This keeps the plant compact and helps fatten the trunk.

Creating Bonsai

In creating bonsai, judicious pruning of both roots and shoots is done to give the small tree its character. This pruning should accentuate the natural shape of the plant, and the shape may be further enhanced by the use of copper wire to bend trunk and branches. The wire may be left on for a single growing season, or even less. Remove it if the fast growing limbs of the plant show signs of being girdled. If necessary, a weight may be suspended from a branch to change its

direction of growth from upward to downward. These techniques are employed to give the plant a more venerable appearance. In nature, old trees have thick trunks and drooping branches, and the objective of the bonsai-creator is to give the appearance of gnarled but gracious old age. Separate foliage masses achieved by "cloud" pruning add to the charm of bonsai. This often necessitates a "cleaning out" of twiggy growth near the main trunk, which should be exposed as much as possible. The addition of a moss carpet to the top of the soil is not only aesthetically pleasing, but also helps to conserve moisture in the soil. However, the dry air in most homes causes moss to desiccate and brown unless it is frequently syringed with a fine jet of water.

Most indoor bonsai, being rapidly growing plants, need re-potting every year or two. This is done by removing the intact soil ball from the container. If root-bound, reduce it about one-third by teasing the outer soil away from the roots and clipping off the exposed ones. Disturb the other roots as little as possible. The small tree can be replanted in the same container after coarse drainage material (gravel) has been placed on the bottom. A layer of dry sand should cover the gravel and be added around the reduced soil ball. Press firmly to compact the soil, then place a shallow dish of water to soak the newly added soil.

At the time of transplanting it is important to prune away an equivalent amount of top growth to keep the root-shoot relationship. After re-potting, the plant should not be placed in bright light. In a dry house it is advisable to keep it in a miniature greenhouse or plastic bag for a few days until the new roots start growing. Re-potting is best done in autumn or early spring before the buds begin to swell.

Good Indoor Subjects

We have already mentioned the genus *Citrus*, and perhaps the best of these is the calamondin orange (*Citrus mitis*), which has fragrant flowers, small fruits

A ten-year-old plant of *Punica granatum nana*. Fruit is less than an inch across.

and relatively small leaves. Another tree which produces charming flowers and fruits is the dwarf pomegranate (*Punica granatum nana*). Several of the small-leafed figs do well when trained as bonsai. One of the best is *Ficus diversifolia*, which bears many fruits sized in good proportion with the trunk and leaves. The Natal-plum (*Carissa grandiflora*) has a somewhat stiff habit but may be trained into semi-cascade style to show off its glossy, dark-green leaves and fragrant white, starry flowers.

One of the most rewarding plants for indoor bonsai is *Malpighia coccigera*, which blooms profusely several times a year and is a delightful subject with its two kinds of leaves, both hollylike and oval, and beautiful pinky lavender flowers.

Another floriferous little bush which makes a fine bonsai is *Serissa foetida*. There are many varieties of this. Perhaps the most charming is the double-flowered one. Another has variegated leaves which add to the attractiveness of the plant.

Small-leafed gardenias, particularly

Gardenia radicans, may be trained as bonsai and reward their owners by producing fragrant white flowers. One word of warning though: Gardenia roots are quite subject to nematode infection, which can retard healthy growth.

A temperamental bonsai subject is rosemary (*Rosmarinus officinalis*). The prostrate form lends itself to cascading and the upright variety makes a fine informal bonsai with small fragrant leaves and heavenly blue flowers.

Tender azaleas are good subjects for house plant bonsai, though it is often difficult to create a shapely plant from one which has whorls of branchlets. It is necessary to do some drastic pruning and careful wiring. Special care is necessary as the wood is brittle and a desirable branch may easily snap. The soil used for these plants should be acidified by the addition of peat moss or leafmold.

One of the most versatile bonsai subjects is *Pyracantha fortuneana,* which is not actually a tropical plant but thrives as a house plant. It also lends itself to training as a cascade as well as an informal upright bonsai, and its charming pale pink flowers are followed by bright red berries.

A house plant bonsai collection requires constant attention, but once one has these charmingly shaped little woody plants to display when guests come, no other house plant will make quite the same impact. For bonsai, like other aspects of Japanese culture, are evocative —some suggest the trees we see on the horizon, others may be replicas of trees clinging to crags in the high mountains. One's imagination is stirred and satisfied.

Trouble Ahead for Dawn-Redwood?

DISEASES have a nasty habit of catching up with plants that are heralded in gardening books as trouble-free. This has finally happened to dawn-redwood (*Metasequoia glyptostroboides*), a tree long thought to be extinct but found wild in a remote part of China in 1944. This "living fossil" was introduced to America in 1948 by the Arnold Arboretum of Harvard University and has made its way from there into gardens around the world. A fast-growing tree (but without the customary weaknesses associated with this trait), dawn-redwood is remarkably adaptable to different climatic conditions. The attractive comb-like needles, which are shed in autumn, remind one of California redwood (*Sequoia sempervirens*) and bald-cypress (*Taxodium distichum*). It is a fine ornamental.

Now comes a report from Dr. Frank S. Santamour, Jr. of the National Arboretum in Washington, D.C. that dawn-redwoods there have been attacked by a fungus, *Botryosphaeria dothidea,* in one stage of its life cycle. It has girdled the stems and caused severe dieback in the upper portions of the arboretum's trees. The disease is not a true killer, because it strikes above "eyeball" level, according to Santamour, and has been found so far only in the Washington area. However, the fungus is a fairly common one, known to cause apple spot on fruit and canker on redbud (*Cercis*). There is no cure as yet, but Santamour and his colleagues have inoculated ten dawn-redwoods, and one of them has shown preliminary resistance to the fungus. If it remains free of disease, the particular tree will be propagated by cuttings and likely be given a cultivar name.

AN INTERVIEW WITH HENRY M. CATHEY

As Chief of the Ornamentals Laboratory of the U.S. Department of Agriculture in Beltsville, Maryland, Henry M. Cathey is one of the leading figures in American horticulture. This tall, courtly, soft-spoken southerner from the foothills of North Carolina is still very much interested in research, and some of his discoveries have already changed commercial floriculture, but in recent years he has also emerged as a peripatetic, forceful salesman for the green world at large. Equally at home in Washington, San Francisco and New York as in hundreds of small towns across the country, he has helped bridge the gap between the plant science community and the home gardener as much as anyone in government service. Here follows an interview with Dr. Cathey:

When did you become interested in plants?

I guess I have always had the interest. The awareness of plants is a tradition on both sides of my family. Three generations ago there was a Henry Cathey who traveled through the mountains of Appalachia. He was known for his singing and for his apples. Also, my grandmother, who lived next to us in our home town of Davidson, North Carolina, let me crawl around and help in her garden. At 15 I had my first job, potting up plants for a florist in Cornelius, North Carolina.

Where did you attend college?

Davidson for two years, then North Carolina State in Raleigh. I enrolled in floriculture and enjoyed two worlds. At night I painted watercolors of flowers and during the day I gardened. I sold the watercolors for money to buy bulbs to plant to have flowers to paint. This was recycling! The paintings weren't very good but they taught me an appreciation of plant form.

I was also completely dazzled with ecology. In floriculture in those days—the late 1940's—you weren't supposed to be interested in ecology, but I was fortunate to have a couple of professors who were as interested in the plants of the swamps as those of the greenhouse. Today floriculture meets the swamp.

Why did you go on to graduate work?

I didn't, at first. I worked as a florist for two years. Then as part of a project to beautify Mooresville, North Carolina, which was a small mill town with a railroad running through it, I was asked to give a course on plants. Despite my B.S. (with honors) in floriculture, there were many questions I couldn't answer. So,

upon the advice of one of my old teachers, I decided to apply to Cornell University in Ithaca, New York. I had no fellowship but had saved $1000 and made my first extended trip north.

What was your research at Cornell?

My adviser was Professor Kenneth Post, who had written a standard text, *Florist Crop Production*. It's still used today. He asked what greenhouse problem I had. I told him of my difficulty in flowering chrysanthemums the previous summer in North Carolina. In a moment he was on the telephone to an Ohio grower, who agreed to send us a number of chrysanthemum cuttings. Four years later, in 1955, the florist industry gave me its top award for research on chrysanthemum-flowering. In that time I underwent a complete metamorphosis.

What has given you the most satisfaction in horticulture?

It's on two levels. First, when the daffodils in my yard are blooming, my best friend, a little boy next door, calls over: "Dr. Cathey, it's spring and you are with it." To be fully identified with the growing of plants is a real pleasure.

What is the other level?

To stand in front of a plant and for the first time get new information from it. This may have to do with the effect of lights on growth, or perhaps with chemical growth retardants. The latter were first thought of as curiosities but now have a use in commercial fruit-tree growing, in vineyards and with other crops. There is a special pleasure in showing visitors the greenhouse bench in Beltsville where concepts came alive.

Are you still interested in research?

Yes it's my basic interest, if by that you mean relating information to need. So much research in horticulture doesn't relate to a need or priority but to a personal hobby. Two or three times as many researchers are pursuing hobbies as are engaged in solving real problems. There are lots of people working on little problems. Research, as I see it, is truly only a step, and the results have to be applied by others to be successful.

What do you mean?

Much information just "sits on the shelf" after it is published. I've had an example of this. My biggest research disappointment concerns the hybrid rhododendron. A rhododendron in flower is the premium gift plant. Florists could profit greatly by it. Some years ago I discovered a way to flower hybrid rhododendrons, regardless of size, at any time of year. The rhododendron has a "complex language" but the flowering can be controlled as effectively as with a chrysanthemum. Because it requires several careful steps no one has followed up.

What are your major research interests now?

Creating a totally new artificial light system for plants is one of them. Our present methods are not satisfactory in experimental work. Also, the energy crisis is making us seek more efficient light sources. As heating oil becomes scarce too, we must find better ways to keep greenhouses warm. You can't very well put a woolly on a hothouse petunia.

My other interest is with environmentally tolerant plants. The lists we have of them are not reliable.

In what way?

They are not based on clones. These days most woody plants, street trees in particular, are propagated by grafts or cuttings. They are selected for one superior trait or another and won't come true from seed, but what is not recognized is that they may differ in environmental tolerance from the species to which they belong. Wholesale nurserymen from all over the country are now sending us clonal material for testing. In a few years we can begin to talk about performance.

Isn't there a danger in the widespread use of clones, the spread of viruses, for instance?

Viruses are creeping into all of our horticultural plants. Because all of the

plants of a clone have the identical constitution (*i.e.* they are literally one individual), a disease can pose special dangers. Developing virus and disease-free plants from single cells of a wide range of plants is one of the challenges of the coming decade. Growing such plants from a pollen grain or a larger part of the plant (the entire field of meristem propagation) is going to be a very important feature of our time. It is not an elixir. Such propagation is extremely demanding. (*Editor's Note*: See page 18.)

Do you foresee any other big change with consumer plants in the coming years?

Yes, with vegetables, fruits and cut flowers. Many of the common crops, except for landscape plants, will be grown in the tropics and shipped north. It will no longer be economical to grow a carrot in Connecticut. This is too bad because supermarket vegetables already leave much to be desired in taste and uniformity. We should see a major interest in the home production of vegetables—to beat the prices and to occupy the increased stay-at-home-time due to gas restrictions on driving.

What else can be done to improve the quality of food and ornamental plants?

I'd like to see consumerism come to the vegetable, fruit and flower counters. Why shouldn't plant produce be dated when picked? We do this with milk, eggs and cheese. Plants are much more alive—in their own way—and deteriorate rapidly when plucked from their growth source.

If you had room in your yard for just one tree, what would it be?

May I have different moods? I'm not just one person, you know. Doesn't your handwriting change in the course of the day? Mine does. When I am writing very tightly my favorite is the white oak (*Quercus alba*). I like its leaf and its bark and the way it sucks in to stand up. It's a glorious tree.

For a fun tree, I would choose *Koelreuteria*. I love the pods and the falling leaves, also the tree's openness and brittleness. One concept we must develop in this country is the disposable plant. We tie ourselves emotionally to one tree in one location. I like to plant new trees every year. Too many cities did their landscaping thirty years ago. Now they are all grown up and nothing new can be tried.

Do you do this in your own garden?

Yes, I'm constantly chopping out, digging up and recreating. This is the exploring part of my nature. There are so many plants I would like to try. Sometime I am going to plant fall-blooming bulbs in my garden. Within a year we may have a project to see what controls their flowering! Before you do experimental work, you have to learn how to grow the plant. The actual growing is missing in so much horticultural research.

Do you detect a rise in general gardening interest?

Yes, it is all around us now. Horticulture has come of age. We used to think in narrow terms, and there were many separate fields. However, words like olericulture and pomology are passing out of the language today. People are interested in *plants* and I think that is great! During supper parties I am constantly besieged with questions on how to grow them. Recently, even my 14-year-old daughter, with no knowledge on my part, used her own money to send away for three cactus plants. And I don't even work with cacti at Beltsville.

Has horticulture become a religion?

I don't like to compare the two. My family and I are regular church-goers. There are many states of grace and horticulture is but one of them.

If gardening is more popular now, how do you explain the apparent decline in variety of plants available to the home gardener?

It's not apparent, it's real. Today most florists offer only five cut flowers, maybe three pot plants, and two corsage flowers.

(Continued)

Henry Cathey with Senator George D. Aiken and friends in U.S.D.A. ornamentals greenhouse.

A nursery may concentrate exclusively on yews or privet. Horticulture has become a business like any other and is slowly emerging as an equal opportunity employer. This is healthy, but I do regret the loss of diversity in plants offered to the public.

What do you think of the organic gardener?

I have always been one and have spent my whole life churning up leaves to return to the soil. I mulch everything. The saddest thing in America is to drive down the street and see big polyethylene bags of lawn clippings and leaves by the curb. This is obscene. The return of organic matter to the soil is the beginning of any sensible gardening.

Do you have any reservations about organic gardening?

The art of many of the procedures does not relate to known principles of biology.

What about pesticides in the home garden?

There is a time for them if other conrols don't work. However, we may be in for a time of trouble. All of our horticultural plants are considered a "minor crop." Most chemical companies won't seek any governmental registration of our spray materials *for anything*, whether we need them or not. It is up to the American Horticultural Society and other gardening organizations to get together and decide what chemicals are really needed. Incidentally, there is only one ornamental entomologist in the entire U.S. government.

Is biological control of plant pests the wave of the future?

Biological control has always been here. It is the way nature operates on the grand scale. The problem occurs when it is applied to the home garden, a "microdot" in which the conditions seldom exist to support the predator insect. I have brought lady bugs and preying mantises into my garden for years, but my *Pieris japonica* still has unbelievable lace bug infestation. You can't restrict a predator insect to your own yard!

What about insect control in the home and apartment?

The major control of house-plant insects is still hot soapy water, a good scrub brush, and time. You have to do this with some house plants every second day for some time because of the eggs, and it is important to cover the breathing pores of the leaves with soap. This is the alchemy of Grandma's old gardening books. It takes a while but I like to call this "quality time"—time to think, review, and relax. Gardeners are returning to it.

Do you have some new plans for the coming year?

Apart from research and other routine activities, including the writing of government "Home and Garden" bulletins, I plan to go out into the communities—the neighborhoods—in the Washington area and help spread the message of the green world. Everyone in horticulture should do this because an ever-increasing number of people, from all walks of life, have become interested in plants. The strength of this country is still in the communities. I want to talk to people in their language, not the language of the horticultural scientist. The title of my talk is "Paradise Found" and I even plan to come on stage bouncing a green basketball. Getting the message across is the important thing.

Late tomatoes come into bearing sooner with this practical, low-cost growing frame

A MINI-GREENHOUSE FOR THE GARDEN

Catherine Ganske

From Organic Gardening, February 1973

My garden greenhouse tomatoes shot up and were in production before those in the peat pots which had enjoyed a month's head start. The extra height of my garden frames allowed my greenhouse plants more head space, and they were able to grow up taller under protection before it was time to transplant them.

It all began one day when my son Curt came home from school to announce that all second-year vo-ag students who had completed their welding training needed projects that could be completed in class.

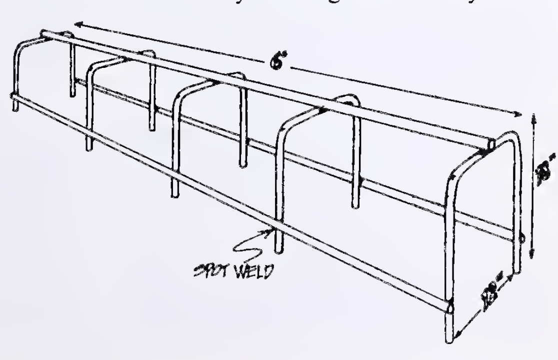
"Great!" I said. I had just the project for him. We went to purchase round steel rods, three-eighths of an inch thick which we cut into four- and six-foot lengths and then bent into U-shaped ribs. Welding them together, we made two 6-foot-long frames, 18 inches high and 12 inches across at the top (see sketch). For good measure, we made another frame 8 feet long and 24 inches high, and then, for added strength, welded 6-foot-long strips 3 inches from the bottom of the U-ribs. Cost of the rods was just under $13.

Next, I bought four sheets of clear 9-by-12-foot plastic for one dollar each. I used two sheets for double protection on the 8-foot frame. Doubling the sheets to 6-by-9-feet proved perfect for our smaller mini-greenhouses. We planted our seeds in a regular garden row and set the frames in place, pushing the ends of the rods 3 inches into the soil for extra stability. Then we stretched the plastic over the frames and shoveled soil against the sides to hold the plastic in place. The ends were folded down and held in place with soil and hay and topped by a big rock.

When ventilation was needed, the ends were folded back up over the top. Just that simple! On extremely cold days heavy sacks or blankets protected the young plants. The steel rods could easily hold them, and large rocks helped keep them in place in case of high wind. Hay thrown against the sides provided enough protection from light frosts.

The three frames gave me 20 feet of protected row space in which to start my plants. Actually I planted two rows 6 inches apart under each frame, so you might say that I had a 40-foot garden row under plastic for a total of 17 dollars. And they are reusable.

If you would like to have a mini-greenhouse made and do not weld, look for a vocational student in school who is looking for a welding project and start those seeds directly in the garden—early!



When completed, the 6-foot-long metal frame stood 18 inches high and 12 inches wide. A second frame is 8 feet long and 24 inches high. Cost of the rods for both frames was less than $13.

Marjorie J. Dietz

A recent survey showed that fertilizer for trees can be spread on the surface rather than being poured into holes laboriously dug in a circle around the tree's outer branch line.

DISPELLING TREE MYTHS

C. L. Wilson and A. L. Shigo

From American Nurseryman, April 15, 1973

Some practices in arboriculture are based all or partly on myths rather than on scientific facts. Since Dutch elm disease (DED) was discovered in the United States, for example, the public has been bombarded with claims of cures. Although most stories of cures for DED tend to come and go, some unfortunately persist and are considered bona fide practices. To date, there is no proven cure for DED. (However, there is hope that new injection methods with systemic fungicides may provide the answer.)

Cures for DED, like cures for cancer, include a high percentage of myths. The unfortunate thing is that, many times, the myths tend to overshadow the real scientific progress that is being made toward combating these problems. Also, the competent researcher is often erroneously associated with these myths, and this tends to diminish public confidence in the research that is being presently carried on.

Cavity Filling

The arts of cavity filling and wound treatment have changed little since their inception, although scientific knowledge of tree-wound healing and decay development in trees has increased considerably in recent years. The new information in these areas serves to dispel many of the myths that have been associated with them. However, due to poor communication, many practices based on myths are applied by arborists.

Results of recent research indicate that trees have a tremendous capability for naturally walling off (or compartmentalizing) decay that may follow wounding. Soon after wounding, a barrier wall begins to form. This wall separates tissues present at the time of wounding, which may be invaded later by decay-causing microorganisms, from tissues that form following wounding and remain free of decay.

In filling cavities, arboriculturists have tried to perform an operation on trees similar to that performed by a dentist on man. They attempt to clean the cavity completely, just as a dentist does. But there are many basic differences between the development of decay in a tooth and decay in a tree. In a tree, if the protective wall surrounding the decay column is broken during the cleaning operation, the

decay is encouraged to spread farther.

Based on present knowledge of wound reactions, in trees it would be advisable to leave part of the decayed wood when filling cavities to ensure that the protective wall behind it is not destroyed. It should also be kept in mind that the material that is used to fill the cavity does nothing to stop decay. It functions only to structurally strengthen the tree and, perhaps, to provide a surface over which callus growth can close the wound.

Wound Dressings

Although wound dressings have been used for years, presumably to stop decay development in the trees, the authors were amazed to find that there is no scientific evidence to support this myth. Again, man has tried to treat trees the way he treats himself, and this does not always bring satisfactory results.

To determine the effects of dressings on tree wounds, scientists initiated experiments in 1971 with several common wound dressings. American elms in Ohio and red maples in New Hampshire were wounded artificially, and three different wound dressings—shellac, polyurethane varnish and an asphalt-based dressing—were applied to the wounds. Some wounds were left untreated to serve as controls. To date, there is no difference in the amount of discoloration and decay between the treated wounds and the controls.

Trees begin to form barrier walls to isolate damaged tissue soon after they are wounded. During the growing season, the cambium initiates chemical and anatomical ehanges that result in the barrier wall. The pioneer microorganisms attack the tissues exposed by the wound in a wave action.

The chemically altered tissues behind the wound are resistant to most microorganisms. But, when conditions for invasion are suitable, some bacteria and fungi can attack.

As these pioneers advance, they alter the tissues. Other microorganisms can then follow, thus creating the wave action, or a succession of microorganisms. It is important, therefore, to aim treatments at the aggressive pioneer microorganisms, since they start the invasion.

The best way to do this is to help the tree itself. After wounding, clean all torn bark from the wound, then shape the wound and, to increase the vigor of the tree, prune all weak and dying branches. Also, water and fertilizer should be added to prevent further weakening. The tree will quickly compartmentalize the injury.

Fertilization

Proper fertilization of trees generally yields rapid and rewarding responses through increased growth and improved tree vigor. However, fertilization has been given credit it does not deserve for a number of other responses. Some contend that most (if not all) disease and insect problems can be controlled through proper fertilization. Although fertilization may influence the establishment and development of pests (in either a positive or negative way) no tree pest has been controlled through fertilization alone. In fact, high nitrogen fertility favors such diseases as fire blight and Dutch elm disease.

Homeowners often believe the myth that, if a little fertilizer is good, a lot of fertilizer must be better. More trees may be killed by receiving too much fertilizer than by receiving too little.

It has generally been recommended that fertilizer be applied to holes made in soil throughout the area of root development. This recommendation is also based on a myth. Recently, researchers at the Illinois Natural History Survey showed that it may be just as effective (and much easier) to spread nitrogen fertilizer on the surface around the tree and water it in.

New myths on trees and tree care spring up all the time. With recent added concern for our environment, trees have been promoted as air purifiers. However, very little research information is available on the effectiveness of trees in removing or filtering air pollutants.

HOW PLANTS FIGHT BACK

They have defenses against their own 'sore throats'

Carl H. Beckman

From Rhode Island Resources, Winter, 1973

When we humans get a sore throat, a cut or a blister, the reddening or inflammation that appears is part of a process of defense and healing. Without this process, we would die from the slightest injury or infection.

So it is, also, with higher plants. Although they differ in many respects from warm-blooded animals, many of their cellular functions are similar. Plants are beset by all sorts of injuries that become infected. Roots become chewed by insects, torn by golf shoes and hoes, while stems are cut and punctured and torn by high winds, by sap-suckers, by apple pickers and by little boys with jackknives. All of these injuries become readily infected. Plants have their own systems of defense, however. Without them, tomatoes and cabbages and potatoes and elms would not exist.

One such defense process involves the conductive systems of plants. Unlike humans, who have a single blood stream with a heart to provide circulation, plants have two separate systems. One flows upward carrying water and soil nutrients from the roots to the leaves, while the other system carries foodstuffs downward from the leaves, where they are manufactured, to all other parts of the plant.

The water and nutrient system is formed by long, living cells that are laid down end to end. These cells deposit special materials as ridges in the wall so that the wall membranes are reinforced. Then the contents of the cells dissolve, leaving long, open tubes with reinforced side walls and occasional reinforced end walls that now form screen-like grids across the tubes.

Sun Energy

The energy for carrying the water upward in the plant is provided by the sun. As the sunlight strikes leaves, it causes evaporation of water from them. This evaporation sets up a suction that is transmitted throughout the minute water columns to the smallest rootlet and causes the upward flow of water through the system.

Injuries and infections of the water conducting systems are an everyday occurrence in the life of a plant. With such an open system, the danger is that infectious organisms will get in and be carried quickly up the superhighways that the water vessels provide. Germs do get in, but fortunately those sections of the superhighway that are infected are usually sealed off quickly. Since there is normally a much larger transport network than is needed, and since new lines are being laid down all during the growth period, the continued sealing off does not ordinarily harm the plant.

Defense Process

This defense process—how it works and what happens when it fails—has been identified and studied by researchers of the Rhode Island Agricultural Experiment Station with financial support from the U.S. Departments of Agriculture, and Health, Education and Welfare. The battle between an infecting organism and a plant, we find, is a race between the invading forces and the defensive forces, with all sorts of weaponry involved.

Let us assume that a grub has chewed a hole in a root of a tomato plant. Since there are thousands of single-celled spores (seed) of microorganisms in the soil water, some of these are quickly sucked into the wound and up into the tube system. These spores are the mobile units for many parasites and they literally race up the tube network until they reach the first of the many gridded cross-walls. Here further progress stops until the

Forests, front lawns and farms exist because the defense system of most plants works effectively against diseases. This is a section of the woodland in the National Arboretum, Washington, D.C.

U.S. National Arboretum

spore can send out a growth strand to penetrate the cross-wall and produce another mobile spore on the upper side of the membrane. The new spore then is in a position to race off to the next grid. This process takes about two days.

In the meantime, however, the first in a series of three defensive weapons is brought into play by the plant. First, the membranes of the side walls and the grid itself are caused to swell until the tubule is filled with a jelly-like substance much like apple jelly. The new-formed spores of the parasite are made immobile in this jelly. The parasite begins to produce enzymes that chemically chew up the jelly, but by now a second defensive process is well underway. This process involves a rapid growth of living cells that surround the tubules. Sack-like growths push into the infected vessel from all sides until it is completely walled off. Finally, chemical substances, called phenols, are released from specialized cells that store them, apparently for just such an emergency. The phenols serve to tan the whole new structure, much as shoes are tanned, so that it is highly resistant to chemical and physical wear and tear. This is how the defensive forces of the plant win the fight, as they do most of the time, day in and day out.

There are certain instances, however, in which the plant loses the battle. When a susceptible plant is invaded by a virulent parasite under suitable temperature conditions, the well-integrated defense system becomes disrupted. The gel forms, but it doesn't persist for more than a day. The sack-like outgrowths begin to form, but then their development is delayed for several days. In the meantime, the spores of the parasite leapfrog from cross-grid to cross-grid until the advancing wave of the parasite has outrun all of the active defense systems of the plant.

Eventually, the defensive forces do get the tubules sealed off, but only after the invading forces have advanced throughout the whole water-conducting system. When the defense finally comes into play, it seals off the whole water-conducting system. The water-conducting tissues then cannot carry sufficient water to meet the plant's needs. If the resulting water shortage is only moderate, involving only a portion of the conductive tissue, the plant's growth will be stunted and some branches may die. But if the shortage is severe, the plant will wilt and die. This is how American elms die when they become infected with the Dutch elm disease.

The fortunate fact, however, is that the defense system of most plants work effectively most of the time, or forests, farms and front lawns would not exist. Where they do not work, plant scientists are busily breeding stronger resistance processes into those plants are are important to us. This is being done with elms, potatoes, cotton and bananas, and many other crops all around the world.

MERISTEM PROPAGATION

New techniques to affect the plant world—and indirectly our own lives

Georges Morel

ONE of the main features of higher plants is the way their stems and roots elongate. At their tips small clusters of cells remain embryonic and during the whole life of the plants develop into new tissues and new organs according to a well organized plan (Figure 1).

It is interesting to note the contrast between plants and animals. In animals embryo formation is restricted to the early part of life. In plants the embryo is formed in the seed but the process of embryogenesis is prolonged during the plant's entire life by the activity of the meristem at tips of roots and branches. In other ways the two extremities of the embryo, the stem end (plumule) and the root end (radicle) perpetuate themselves in the meristems. The structure and function of the stem and the root meristems are quite different.

Fig. 1 Carnation meristem. All leaves of bud have been removed to show apical meristem. in center as a small shiny globule.

In the growing tips of all branches (the apical meristems) part of the cells keep dividing while others develop into new organs, stems, leaves and so on. The distinctive pattern of each plant, no matter how complicated, is contained within the meristem. The shape of each plant is the reflection of meristem activity. For example, in some species the meristem, which during the early life of the plant produces tight rosettes of leaves, as in cabbage or lettuce, suddenly changes its pattern to produce long floral stems when flowering has been induced.

Meristem Culture

Years ago I became interested in the study of factors underlying growth and differentiation of the apex. What is the degree of autonomy of the meristem? Is it able to grow independently by itself when excised and cultivated in a nutrient medium which supplies essential mineral salts and the sugar necessary to the life of each cell? Or is this growth and differentiation into organs regulated by signals coming from other parts of the plant?

The answer to this question is not simple. In the lower (non-flowering) plants such as ferns, they seem to be entirely autonomous. In higher (flowering) plants they show different degrees of autonomy. The excised meristems of many non-woody higher plants need only the plant hormone called gibberelin. This growth regulator is normally produced in young leaf primordia (the embryonic leaves) and is translocated to the growing tips. The role of this regulator is very specific. Briefly, normal stem development can occur only with gibberelin; without it the meristem produces only

distorted calluslike outgrowths. Other species require, in addition to gibberelin, an auxin, a cytokinin, or even other unknown factors which are produced by the roots. Most of them have a specific requirement for a high potassium concentration and will grow *in vitro* (*i.e.,* in artificial culture) only when the nutrient medium contains about five times the optimum concentration for callus growth.

In order to grow the apical portions of stems such as dahlia, carnation, chrysanthemum cuttings or potato sprouts, the apices are taken out and the leaves are removed. They are then sterilized in a clorox solution, rinsed and the buds are dissected under a dissecting microscope with sterile needles or microscalpels made of pieces of razor blade. Leaf primordia are removed one by one and when the naked apex, which averages 250 microns (0.00098 of an inch) of the tip is finally exposed, it is excised and transferred to a small test tube containing a nutrient medium. Here it resumes its growth. This excised apex elongates slowly, producing new leaves and new roots. In one or two month's time a new plant is formed. It then can be transplanted into soil or propagated *in vitro* by means of an aseptic cutting (Fig. 2).

Fig. 2 Chrysanthemum plantlet, two months old, grown from apical meristem in culture.

Producing Virus-free Plants

Once established, this technique of meristem culture has numerous useful applications. The first one deals with the production of virus-free stock. As a rule viruses do not penetrate embryonic tissue, so propagation by seed provides a means of getting rid of them. For example, all the seeds collected from a tobacco plant—infected with tobacco mosaic virus—are virus-free. Unfortunately it is not possible to propagate most ornamental or fruit trees from seeds at the same time and retain their superior traits. (For example seeds collected from the 'Peace' rose or from the 'Golden Delicious' apple will give everything *but* 'Peace' or 'Golden Delicious'. It is the same with potato, carnation, chrysanthemum, dahlia, gladiolus and the majority of other garden plants.)

The reason why the virus does not invade the apex is unknown, but it occurred to me that meristem culture should provide a way of getting virus-free plants from diseased ones. The first experiments performed on dahlias carrying dahlia mosaic virus and spotted wilt virus were very successful. When the apical meristems from the diseased plants were taken out and grown on nutrient agar in test tubes, the young plants thus obtained were found to be virus-free (Figs. 3 and 4).

This technique soon had practical applications, and is now widely used to produce virus-free plants for many crops such as potato, sweet potato, strawberries, sugar cane, and ornamental plants like chrysanthemum, carnation and lilies.

Clonal Propagation

Aside from garden annuals, most ornamental plants are hybrids (*i.e.* genetically heterozygous) and do not breed true. Vegetative or clonal propagation by cut-

Fig. 3 Dahlia 'Reve Rose' shows condition caused by the dahlia mosaic virus.

Fig. 4 Meristem culture results in healthy plant from diseased plant, same variety.

tings or grafting is very easy in some cases, yet may be very slow and tedious in others. These horticultural practices have not changed much over the centuries, and in the case of heterozygous plants, such propagation techniques are too slow.

For example, in orchids the only means of clonal propagation is by division. So-called back bulb propagation consists of separating the oldest pseudobulbs. This forces the development of dormant buds present on the pseudobulbs. It is a very slow process and only allows the doubling of the number of plants every year under the most favorable conditions. It explains the fantastic prices quoted for prized plants.

In the course of our studies on meristem culture we found that meristematic tissues are able to produce buds or roots much more readily than older tissues. In some plants almost any cell is able to form buds which, in turn, develop into plantlets. For example, when a root of horse-radish is cut into very thin slices, and these are placed on moist sand, within a few weeks numerous buds appear on the cut surface. These buds grow into small plants. In others, this bud-forming property is restricted to the outer layer of tissue, the epidermis; thus, when leaves of African-violet or of rex begonia are cut and planted in a mixture of sand and peat, the small plantlets formed on the leaf stalk (petiole) or on the leaf blade come from the epidermis; the other cells of the plant have lost their meristematic potential. In orchids this property is restricted to the cells of the apical meristem.

Let's take the case of an orchid such as a *Cymbidium*. The bud forming the short tuberous stem (called pseudobulb) is short-lived and degenerates as soon as the pseudobulb is formed. Then at its base, in the axils of the leaves, new buds appear which under proper conditions will form the floral stems or new bulbs to perpetuate the plant.

The culture of the meristems located inside these buds affords a new means of propagation of orchids at tremendous speed. For that, after sterilization in clorox solution, the bud is carefully dissected and all scales are removed. The apical dome is excised with the two or three leaf primordia surrounding it. It is then planted on a very simple culture medium, such as used by orchid growers

Fig. 5 Protocorm of orchid (*Cymbidium*) produced by an apical meristem grown in culture. Note the very long root hairs.

Fig. 6 A clump of protocorms of *Cattleya.*

Fig. 7 Small plants of lilies produced by meristem culture.

Fig. 8 Plantlets of asparagus that have been produced by means of meristem culture.

to raise seedlings. There it enlarges and after a few weeks small areas of intense cell division can be recognized on the surface of the tissue, localized either just above the leaf primordium (*i.e., the axil*) or just below this primordium. They seem to originate from the epidermis, and produce small subspherical bulges with root hairs and few scales on the top, identical to the protocorms (Fig. 5).

Protocorm is a term coined by the French botanist Noël Bernard to designate a stage of development of the orchid embryo. The orchid seed contains an embryo which is extremely minute, consisting only of a few cells and weighing but a few millionths of a gram. A gram is only one-twenty-eighth of an ounce. As the embryo develops, when ripe seeds are planted on a nutrient medium containing a mycorrhizal fungus, it assumes a more-or-less spherical form before bursting out of the seed coat. Enlargement continues, resulting in a small globule with a meristematic area at the apical portion giving rise to the first leaf; several rings of root hairs appear at the opposite end (Fig. 5). As the young seedling is formed by the meristem on the protocorm, the structure called the protocorm really represents a stage of development of the orchid embryo.

In the case of the excised apex (*in vitro*) the bulges formed during the growth of the apical end of the bud are really adventitious embryos. If left undisturbed they will quickly develop into plantlets, each similar to a seedling, but if they are sectioned into slices and transferred to a new culture medium, each slice will repeat the process and produce a clump of new protocorms (Fig. 6). Such a procedure can be repeated indefinitely, thus propagating the plant. It is then possible to obtain from a simple bud several millions of plantlets in the course of a year. Such plantlets, which will produce flowers identical to the mother plant, are called mericlones.

These new techniques have brought a real revolution ot the orchid industry. It is now possible to propagate these plants as easily as carnations. Every orchid hobbyist can now afford a beautiful variety which only a few years ago would have cost several hundred dollars.

Similar methods have been applied to the propagation of other ornamentals such as lilies (Fig. 7) chrysanthemums, gladioli and vegetables, such as asparagus (Fig. 8). These methods open a bright new field of wide application and are transforming many traditional horticultural practices.

NAME CHANGES FROM ENGLAND

THE MAJOR publishing event in English horticulture in 1973 was Volume II of the revised edition of W. J. Bean's classic tome *Trees and Shrubs Hardy in the British Isles* (London: John Murray Publishers, Ltd.). It is not a book for the average American home gardener, but the background information should be of special interest to people who work professionally with woody plants.

Major reference works such as this also provide a valuable summary of nomenclatural changes in the plant world. These are based on strict but often complex taxonomic rules. Volume II goes only through the letter M, so gardeners—with a sigh or two—may expect additional changes as the classifiers in the Kew herbarium and their counterparts at other institutions push toward *Zenobia.* However, this is as good a time as any to list the name changes already recorded in the new Bean for well-known trees and shrubs.

Old Name	**New Name**
Aesculus octandra (Sweet buckeye)	*Aesculus flava*
(*Clematis paniculata*) (*C. dioscoreifolia robusta*) Sweet autumn clematis	*Clematis maximowicziana* The name *C. paniculata* is still valid but it refers to a New Zealand species grown only in mild-climate gardens.
Erica carnea (Spring heath)	*E. herbacea*
Euonymus yedoensis (Yeddo euonymus)	*E. hamiltonianus sieboldianus*
Forsythia 'Beatrix Farrand'	Several clones, but not the correct one (which is now extinct) have been distributed under this name. The name is now meaningless.
(*Lavandula officinalis*) Common lavender	*Lavandula angustifolia*
Lavandula spica	Most plants under this name are hybrids between *L. angustifolia* and *L. latifolia.* Some are *L. angustifolia,* others are *L. latifolia.*
Lavandula vera	Most garden plants belong to *L. angustifolia.* "Dutch" lavenders are hybrids with *L. latifolia.*
Lycium chinese *Lycium halimifolium* Matrimony-vine	*Lycium barbarum.* The two species have been wedded into one.
Magnolia obovata	*Magnolia hypoleuca*

Demonstration of trickle irrigation. Dew hose has been placed next to a row of gladiolus. Darkened area shows continuous wetting pattern.

A. L. Kenworthy

RELAX WITH TRICKLE IRRIGATION

Harry G. Ponder

If a productive home garden or a healthy green landscape is your desire and frequent moving of sprinklers is not your idea of fun, trickle irrigation may be for you. This watering technique was developed in England in the late 1940's for greenhouse tomatoes. More recently it has been put to work in orchards and nurseries of arid regions. Due to a lack of publicity its potential application for homeowners has not been appreciated. Based on my research with trickle irrigation in nurseries and home gardens, I believe that trickle irrigation may fulfill an important need around the home.

Why Use Trickle Irrigation?

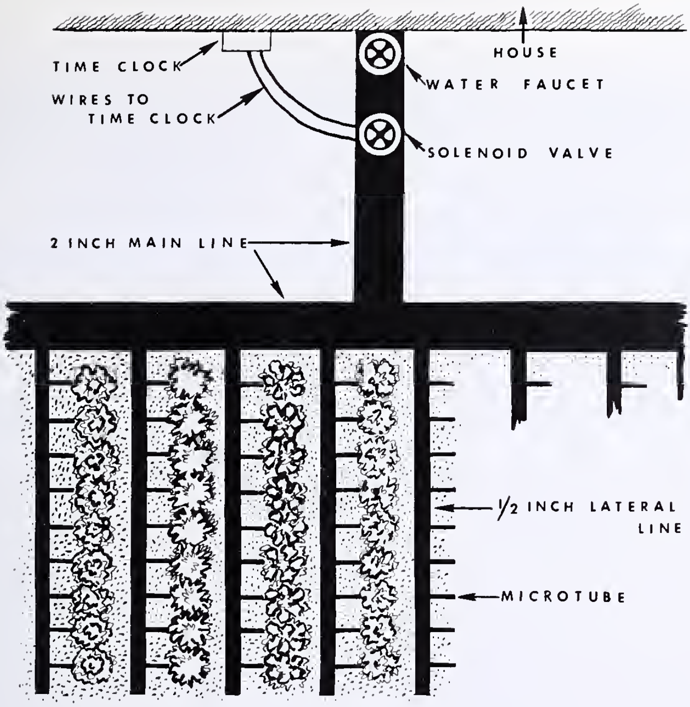
In nearly every part of our country some form of watering is needed to supplement natural rainfall sometime during the growing season. Without it plants suffer from drought. With trickle irrigation water is applied daily. Optimum moisture conditions are maintained continuously for each plant. The results are better growth, better flowering, and better yields. Trickle irrigation acts as an insurance policy against droughts. The water is applied directly to the area in which the plants roots are located and not to the area between rows. This discourages weed growth between rows, and conserves water.

With a completely automated trickle system, a substantial amount of time and labor is saved in the actual watering process. Vacation periods can be enjoyed without worrying about the garden and landscape plants suffering from lack of water. And lastly, this system is inexpensive and can be installed by the average homeowner, from materials that may be obtained locally from a good plumbing supply store.*

What Is Trickle Irrigation?

Trickle irrigation is the daily maintenance of an adequate section of the root zone with enough moisture to prevent water stress. A trickle system con-

*If unable to obtain materials locally, send a stamped, self-addressed envelope to the Editor for a list of suppliers. Also, consult classified pages of your local telephone directory under "Greenhouse Equipment," where much of the material can usually be obtained.



Eva Melady

DIAGRAM OF TRICKLE IRRIGATION

Right: Punch, gromets and the installed micro-tube used in trickle irrigation.

(Continued)

sists of a series of black plastic pipes (½ inch diameter is sufficient for most home gardens) set down along the plant rows so that a pipe lies near the plants. All of these pipes are connected by a single main line from a water source. Periodically an emitter (water outlet) is placed in the pipe to emit water at a predetermined rate to a specific location. A gate valve in the main line can be used to control the system's pressure, or a solenoid valve and a time clock can be used to completely automate the system. The system is also amenable to fertilizer injection.

Home Irrigation

Trickle irrigation operates at low pressure. Since it requires less total water when compared to other irrigation systems, it can be adapted easily to the home water system. A female garden hose adapter inserted on the end of a ½-inch black plastic pipe allows the pipe to be attached to an outside water faucet. This ½-inch main line, which is usually buried to eliminate traffic problems such as lawn mowers and other equipment, runs from the water source to the garden area. It may be run along one side of the garden or, depending on the garden's orientation and size, may be run through the middle of the garden. Upright pipes with connectors are inserted in the main line at all points where a lateral line extends down a planted row. Black plastic pipe (½-inch) can be used for the lateral with emitters spaced at every plant or every other plant.

Microtubes are the cheapest emitters available, and they are quite reliable. They are very small inside-diameter plastic pipes: .025-inch, .035-inch, and .045-inch inside diameter. To install them a small-size calibrated punch, similar to an ice pick, is used to puncture the lateral and insert a gromet. The microtube is inserted in the gromet and is held there by friction fit. The inside diameter and length of the microtube determine how much water is put on a plant per hour. Usually one to two gallons per hour is a desirable flow rate. How long the system

A flow control valve (*center*) installed in a piece of ½-inch black plastic pipe. A gate valve is shown above the plastic pipe.

Arrow points to area where microtube extends from lateral line. Darkened soil area shows wetting pattern between pepper plants.

should operate per day depends principally on the soil type. Other types of emitters, besides microtubes, are available, but they are more expensive.

Dew hose is an alternative lateral to the black plastic pipe emitter system described above. Dew hose is a pliable plastic pipe which is sewn together with nylon thread forming a seam on one side. Water is emitted along this seam and a continual wetted pattern is formed down the row as contrasted to the intermittent wetted patterns formed when individual emitters are used. Four to eight pounds pressure is all that is needed for the hose to operate. For home gardens, the dew hose is very promising.

With an inexpensive time clock connected to a ⅜-inch solenoid valve placed in the main line, the whole system can be automated to run a few hours each day.

The above principles and general design—with a few modifications—can also be used to make a watering system for the foundation plants—often neglected—around the house.

Based on our research at Michigan State University, we enthusiastically endorse trickle irrigation as a tool that the home gardener can use to make his gardening easier and more rewarding.

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Various root systems produce nodules capable of fixing nitrogen. Here, nodule formation is shown on the roots of autumn-olive (*Elaeagnus umbellata*).

Robert E. McNiel

NITROGEN FIXATION

Robert E. McNiel

WHEN nitrogen fixation is discussed in soil and plant nutrition texts, it is centered around the legume crops (alfalfa, clover, soybean) that have been very beneficial to agricultural production. This fixation process, however, is not limited to farm crops. The home gardener who must contend with poor soil may also benefit, since several kinds of ornamental trees and shrubs, both legume and nonlegume, can fix nitrogen.

Besides having aesthetic value, the nitrogen-fixing ornamental plants provide a vital link in the plant nutrition cycle. Nitrogen is needed by *all* plants, and these are able to supply their own needs. Little nitrogen fertilizer is required—in fact the less added, the more productive the fixation. The home gardener may use these species where available nutrition is poor and, provided other growth conditions are good, obtain satisfactory development of the plant.

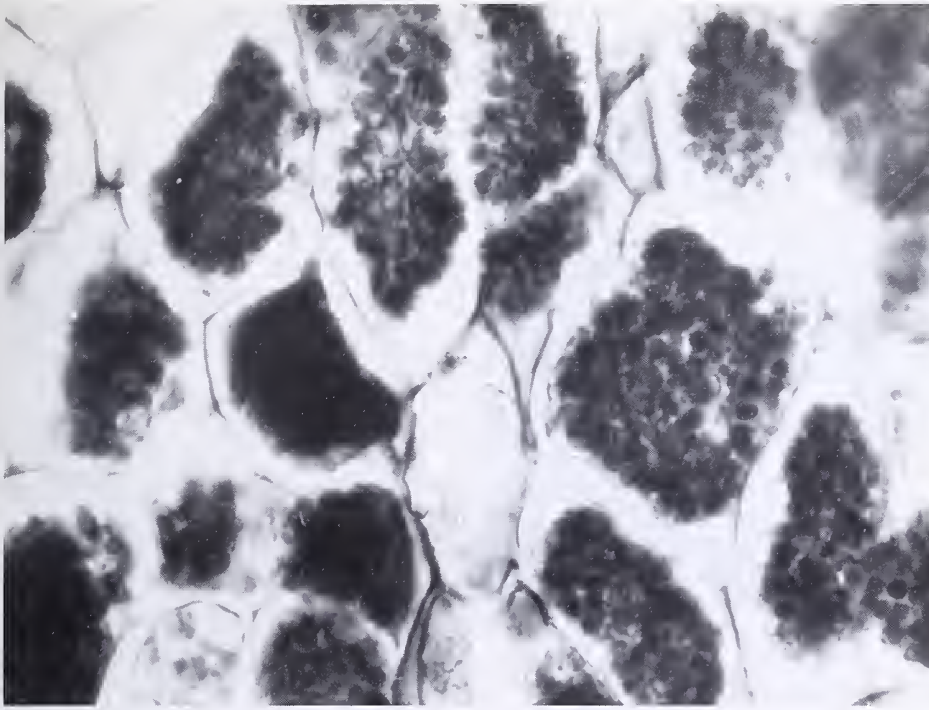
Nodules

Nitrogen fixation occurs in structures called nodules, which are located on the root system. Nodule shape and color differ from one plant species to another. Spherical or cylindrical nodules occur most frequently on legumes, while a many-lobed structure is generally associated with non-legumes. Size is dependent on stage of development and will vary from a few millimeters to several centimeters in diameter.

The nodule is formed by a soil-borne microorganism which enters the plant root. As the nodule is formed, a chemical enzyme process is developed which can change the nitrogen (N) from the atmosphere into a nitrogen form usable by plants (NH_3).

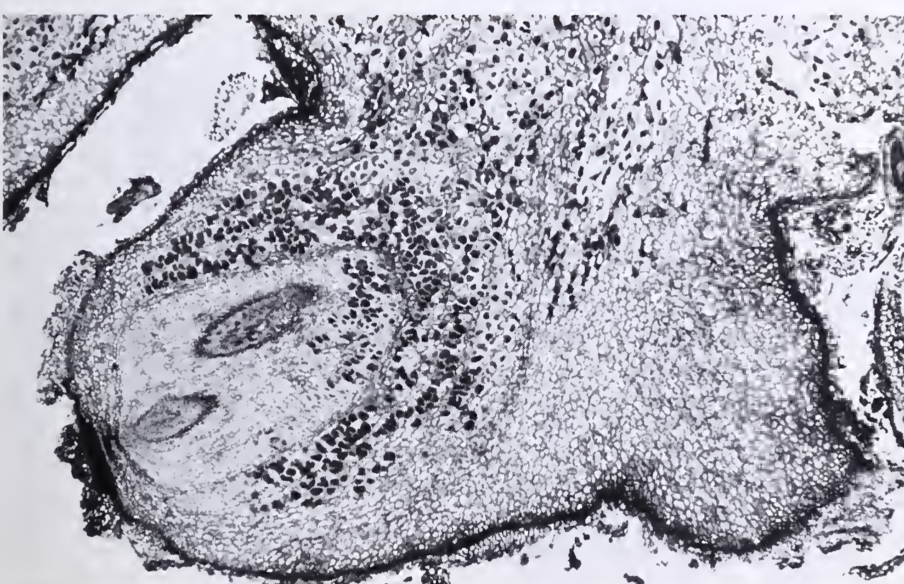
Several species of the soil bacteria *Rhizobia* have been associated with development of nodules on legumes. However, only about one-tenth of all legume species are known to form nodules. The soil microorganisms causing the formation of nodules on non-legumes are not well identified.

Here is a brief list of nitrogen-fixing



Gail Power

Alnus glutinosa is another non-leguminous plant capable of forming nitrogen-fixing nodules. *Above: Alnus* root nodule cells filled with a nitrogen-fixing organism. *Below:* Cross section of *Alnus* nodule.



ornamentals that may be especially useful where soil nutrition is low:

Legumes

Sweet pea (*Lathyrus*)
Lupine (*Lupinus*)
Japanese pagoda or scholar tree (*Sophora japonica*)
Black locust (*Robinia pseudoacacia*) and other *Robinia*

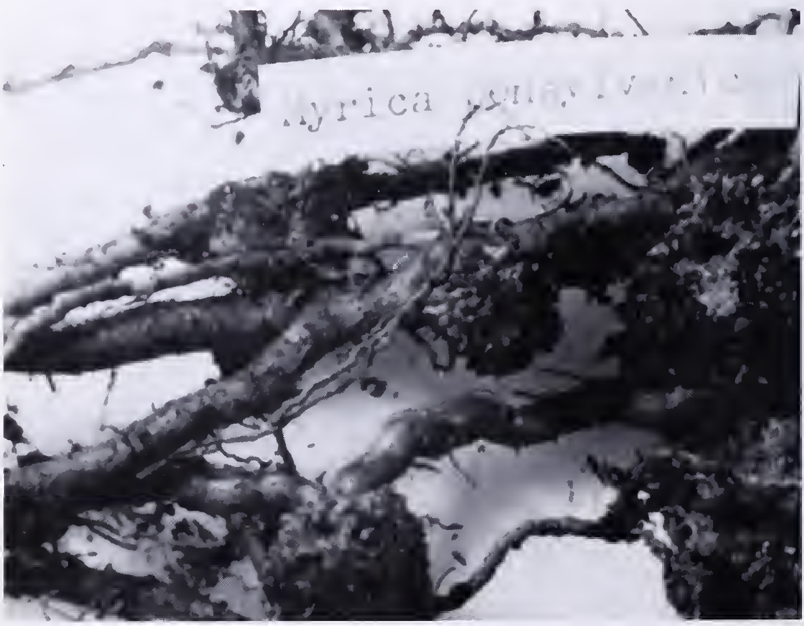
Note: Honey-locust (*Gleditsia triacanthos*) and redbud (*Cercis* spp.) do *not* fix nitrogen.

Non-leguminous Plants

Bearbeary (*Arctostaphylos uva-ursi*)
Manzanita (*Arctostaphylos* spp.)
Western-sage (*Artemisia ludoviciana*)
California-lilac (*Ceanothus*)
Sweet-fern (*Comptonia peregrina*)
Russian-olive (*Elaeagnus angustifolia*) and other *Elaeagnus*
Sea-buckthorn (*Hippophae rhamnoides*)
Bayberry (*Myrica* spp.)
Buffaloberry (*Shepherdia argentea, S. canadensis*)

Two other non-legumes that can form nitrogen-fixing nodules on their roots. *Above:* The sweet-fern (*Comptonia peregrina*). *Below:* Bayberry (*Myrica pensylvanica*).

Robert E. McNiel



AN HERB GARDEN MADE WITH FLUE TILES

Eleanor B. McClure

From FLOWER AND GARDEN, January 1973

IF YOU'D LIKE to grow an abundance of herbs in an easy-care garden, consider planting them in ordinary flue tiles, separated by gravel stepping areas. This construction affords ready access to the herbs, and the resulting pattern of beds and walkways forms a pleasing modular design.

Actually, a modular herb garden is just an up-dated version of such traditional designs as herb wheels and knot gardens, where different kinds of herbs were planted in small beds bordering brick walls or gravel paths. The intricate geometric patterns of neat beds and tidy borders can be delightful, especially when centered about a feature such as a sundial or a decorative garden figure.

Such winsome gardens are hard to construct, however, and the small beds, edgings, and walks demand dedicated maintenance. Moreover, in many parts of the country herbs are not reliable enough to be used in patterns or in trim little edgings. In the Midwest, for example, it is virtually impossible to keep germander (*Teucrium chamaedrys*) flourishing so it makes a good miniature hedge.

In contrast, a flue garden can be installed with comparative ease, and its maintenance can be held to a minimum. Little weeding is needed, and a plant can usually be kept in shape as branches are snipped for picking or drying. Then, too, when individual plants are lost they can be replanted or replaced with another herb without loss to the overall design. The tiles and walkways alone create a strong and permanent pattern.

Another advantage of the modular herb garden: great flexibility! It can be fitted into almost any city or suburban setting. For example, a sunny spot between the drive and garage might accommodate a single or double row of the planted tiles. A larger area near the kitchen door might have a tile arrangement in the form of an L or an inverted U with a gravel stepping area in the center. A sundial or some similar feature could also be added.

Where space is no problem, a checkerboard pattern of the desired dimensions will provide grow-pockets for a large variety of herbs. One precaution, however, should always be taken. Herbs should not be used as edgings for flower borders, where there would be danger of contamination from fungicides and insecticides.

In creating an herb garden the first step is to find a sunny spot, preferably close to the kitchen. Tarragon and sweet woodruff prefer shade, but other herbs need abundant sunlight to develop essential oils and full fragrance.

It's best to prepare the bed before the tiles are installed. Herbs aren't a bit fussy about the soil, but they do appreciate a well-drained bed. A 2-inch layer of sharp sand or perlite (obtainable at a building supply or garden store) can be worked into the bed. A clayey soil can also be improved by adding partly rotted compost—but go easy on the fertilizer! Herbs that are overfed tend to produce excess foliage, but both the savor and the fragrance will be reduced.

Installation of the flue tiles is the hardest part of the task. Available sizes may vary from the large 24-inch squares to small ones measuring 9 by 9 inches. Oblong tiles range from the larger 18 by 13 size down to 9 by 13. All of them, however, are 2 feet long and should be cut in two, for sake of economy as well as ease of installation.

We have cut the tiles successfully with

a cold chisel, chipping along a line drawn around the middle of the tile. It is best to keep the tile filled with soil or sand during this operation, to lessen the danger of cracking. It won't matter if the cut edge is a bit chipped or ragged, for it can go into the ground.

An easier way is to use a small power drill equipped with a circular saw that has a carborundum blade. For best results, cut all the corners first and then saw along the connecting lines. Although the tiles are glazed, they do absorb water and may be subject to chipping or flaking in a very severe winter. This can be prevented by painting them with a rubber base paint—brown, orange, blue, green, or any other color that harmonizes with the house and garden.

The tiles may be installed from 2 to 6 inches below ground level. The beds inside may then be raised by filling with top soil removed in making the stepping areas. These little walkways should be leveled and graveled.

When planting, remember that the tallest herbs should go in the back—shrubby or buxom types like the sages, lavender, catnip, borage, and rosemary. Herbs with fine, airy foliage (fennel, rue, and dill, for example) also make good background plants. For the front of the garden select the ones with attractive, more compact growth, such as balm, parsley, chives, and various thymes.

Perennial herbs must be set out as young plants or rooted cuttings and should be spaced to allow room for growth.

Among annuals which will flourish from spring-sown seeds are anise, basil, borage, dill, parsley, marjoram (which is a perennial in the South), and summer savory.

Seeds may be sown in a special bed or directly in the tile.

Genereux

Vagrant mints are restrained and other untidy herbs look presentable when grown in flue-tile planters. Of practical value are the gravel areas among the flues that afford easy access to any plant—even in rain.

HORTICULTURE—THERAPY FOR THE HANDICAPPED

Diane Hefley

GARDENERS have long realized the therapeutic benefits of their hobby. While working with plants both mind and body become involved in the wonders of nature, and the gardener finds a very special sort of relaxation and gratification. To the ill and handicapped such benefits have even greater significance.

Horticultural therapy, a rapidly growing profession, is the use of gardening and related activities to bring about a desired change in an individual. Although this therapy is used for both its curative and preventive value, it is not considered a separate form of treatment. Rather, it is part of a total program which helps the individual deal more effectively with his surroundings.

Horticulture is being used by many therapeutic professions. At some institutions it is part of the occupational or physical therapy programs while at others it is recreational therapy. Vocational rehabilitation, work-incentive and industrial therapy programs also employ horticultural activities. The particular goals toward which a horticultural therapy program is directed may differ from one institution to another and from one group of handicapped persons to another, but the ultimate aim is the improved physical and mental health of the individual.

One of the best known horticultural therapy programs is conducted at the Menninger Foundation in Topeka, Kansas. Rhea McCandliss, in charge of this program for many years, has summarized its basic philosophy, which is shared by many others in this field:

"We hope that a patient's working in a group, learning to adjust to and consider others; learning to be responsible for living plants dependent upon him; learning and understanding his dependency on nature and plant life; developing a greater appreciation and enjoyment in the plant world which surrounds him, no matter where he may live; being able to accept the disappointments that inevitably come when working with living perishable materials; developing a tolerance to the frustration of a partnership with nature (and thus to other disappointments)—we hope that these things are therapeutic."*

Growth of Programs

Horticultural therapy in the United States has had a long history, dating from Colonial times. One of the pioneers was the Friends Hospital in Philadelphia. Founded in 1813, it is still involved with such activities. Often the 19th-century programs were geared toward crop production or maintenance of the institution. However, as they developed, their therapeutic value began to outweigh their economic value. By the early 1900's many hospitals, orphanages, reformatories and other institutions were conducting a range of garden therapy programs.

After the Second World War, as after the First, horticultural activities had an important role in the rehabilitation of the injured. In the 1950's, many new therapy programs came into being, with much of the work and responsibility assumed by garden clubs, service clubs and religious organizations. In 1968 Rhea McCandliss conducted a survey of 500 institutions—primarily psychiatric hospitals. Of the 216 replying, 64 percent had some form of horticultural therapy, and 49 percent indicated a need for trained professionals in this field. Since that survey, several universities, includ-

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*For more information about the Menninger program, see Rhea McCandliss' article "A Therapeutic Arboretum," PLANTS & GARDENS, Winter 1967-68 (Vol. 23, No. 4), pp. 34-35.

Mentally retarded students from the Melwood Horticultural Training Center in Maryland are engrossed in their task of potting poinsettia plants.

ing Kansas State and Michigan State, have initiated degree programs in horticultural therapy.

Therapy in Action

A recent project of mine was to assess the value of horticultural activities in the rehabilitation of the older mentally retarded individual at Forest Haven, the District of Columbia's home for the retarded in Laurel, Maryland. This is how the program worked:

The initial step was to enlist the voluntary participation of the residents. At the first meeting of the "garden club," a polaroid photograph was taken of each man who decided to join. The photographs were mounted on large paper flowers and used to simulate a garden on one of the walls. Twenty residents joined the club and had their pictures displayed.

Games with which the residents were familiar were modified to teach them certain principles of horticulture. For example, pictures of plant parts were substituted for numbers on bingo games. As the men became increasingly interested in plants and aware of the differences between them, more activities were employed to stimulate this interest. The men had a party on Valentine's Day to which they invited friends from other cottages. They assisted in planning the party by making invitations, decorations and favors. The day of the party they made corsages for the women who were to attend.

As spring progressed, more difficult tasks were attempted. The men learned to start seeds, to make cuttings and to transplant house plants. As soon as the weather permitted, they prepared a small flower bed and planted pansies.

For an indoor project they worked together on the construction of a model garden. This not only encouraged group participation but helped them to feel that the garden would actually be theirs. While working on the model they talked about the real garden that they would build. Several meetings were spent on planning it. Each man was given a copy of a garden catalog. He was encouraged to ask questions about the plants and to select the ones he wanted to grow. This was a particularly useful tool with some of the men who were non-speakers, because they were able to select plants they liked by pointing at the pictures. The men helped select and prepare the area for the vegetable garden in a field next to their cottage. Here they planted broccoli, cauliflower and lettuce plants, as well as seeds of many spring vegetables. The planting required repeated instruction, illustration and supervision, but the actual work was done by the men. Work crews often proved effective as each person was required to remember only one task. For example, one man would dig a hole, another put in the plant and a third cover the roots with soil.

The pride and satisfaction the men gained from their work made the garden so successful that when it came time to plant the summer vegetables the garden size was more than doubled. Corn, cucumbers, squash, tomatoes, eggplants, peppers, onions, beans and okra provided fine fare for several picnics that summer. In addition to the vegetable garden, the men prepared and planted four flower beds around their cottage. The flowers from the beds were used to decorate the cottage or given to friends.

The highlight of the summer was a corn-on-the-cob and tomato feast to which the garden club members invited friends from all over the center. With flowers from the annual beds and vegetables from the garden, these men were able, perhaps for the first time in their life, to share with others something they had produced with their own hands. One of them, Francis by name, set the example for everyone by always urging visitors to "take some home."

Many opportunities present themselves for developing similar programs in horticultural therapy. Homes for the elderly, schools for the blind and handicapped, prisons and reformatories are among the many places where there are people who could benefit from working with plants. The future for this kind of therapy is bright and challenging.

Above: Students from the Melwood Horticultural Training Center working on the grounds of the Kennedy Center, Washington, D.C. *Right:* A student at the Melwood Center working in flower arrangements.

Left: An eastern spiny softshell turtle, one of several of the same breed that reside in the pond of the Japanese Garden, in the cooperative, if a bit unsteady, hands of a guard. *Opposite page:* Spiny softshell turtle swimming to pond's surface for a handout.

A chelonian commentary—

TURTLES IN A BROOKLYN LAKE

Herb Clement

DURING THE SUMMER of 1973 I conducted an informal survey of the turtles living in the Japanese Garden Lake at the Brooklyn Botanic Garden. My purpose was to learn whether turtles foreign to the latitude of New York City exist in the lake and overwinter there. Second, I wanted to determine (and still do) if the turtles in the lake breed and lay eggs, if the eggs hatch, if the hatchlings are viable and, at the most extreme limit of conjecture, if interbreeding between resident species exists.

Barriers to Research

Despite the wholehearted cooperation of the Brooklyn staff, several problems presented themselves at the outset of my investigation. One of them was the gardeners' understandable partisanship with birds. ("If you see that snapper that keeps eating the ducklings, catch it and kill it, will you?") Another problem was the continuing donations of baby turtles to the lake's population by neighborhood children (or perhaps parents). These "charitable" activities virtually eliminate the possibility of an accurate census of hatching young unless the turtles are caught while hatching and marked. The donations were encouraged incidentally, by the somewhat vague advice to "release your turtles in Prospect Park's Japanese Lake," published in the summer issue of the New York Turtle and Tortoise Society's informal newsletter, *The Plastron Papers.*

The Garden's Japanese Lake operates much like a bank, as far as turtles are concerned. There are deposits and there are withdrawals. Both actions complicate the conducting of a truly reliable survey.

Time and Technique

"Turtling" was done in the early morning hours before the Botanic Garden opened, so as not to interfere with visitors' appreciation of the Japanese display. Ob-

Herb Clement/Mike Calle

servations were begun, but shortly discontinued in favor of temporary capture, for this permitted accurate identification and, later, numbering of individual specimens.

Because the turtles in the Japanese Lake are almost tame (the result of handouts from visitors), it was fairly easy to catch them. Fish heads tied to a hookless line about a foot below a float were cast across the lake, and slowly reeled back to the base of operations—the tea house. A sudden lunge with a long-handled crab net usually trapped whatever turtle ate the submerged bait, after which the reptile was dried off, marked and placed in a convenient litter basket until the enamel number dried. Then the animal was released. Often it returned to the bait immediately, much to the annoyance of the census-taker, who was trying desperately to keep a straight face throughout the undignified proceedings.

Many a staff gardener caught the author prostrate on the tea house floor, urging a paddling turtle to swim closer with such words as "Come on, baby, just a little bit nearer," or cautioning a hard-shelled interloper to "get away, dum-dum. You already have a number!" Such is the price of research into life in the animal kingdom. It is well known that one gets nowhere sitting on his dignity.

Results of the Survey

The initial investigation revealed the following types of turtles living in the Japanese Lake—nearly all of which showed signs of living a bounteous existence. Sex designation is indicated here as it is in zoological park records: 1.2 = one male and two females.

Because the *Pseudemys* genus is considered by many experts to be a nomenclatural nightmare (intergrades are often more the rule than the exception) the most prominent features were relied upon for identification. Intergrades are marked with an "x."

The Mating Game

In July of 1973, one instance of mating behavior was observed between a map turtle (*Graptemys* sp.) and a red-eared turtle (*Pseudemys scripta elegans*). This

was the only observation of intergeneric courtship observed, although the characteristic backward-swimming of male red-eared turtles, as they vibrated their lengthy toenails in front of female redears' heads and necks, was witnessed many times. Eastern spiny softshells (*Trionyx spinifer*) were observed mating in shallow water, partly concealed by weeds. Reports by staff members that hatchling young of this species were discovered as they were preyed upon by birds, were not confirmed by evidence in hand. The hatchlings were reported in early November.

July also provided a glimpse of nesting activity on the part of a red-eared turtle. The gravel path she chose proved too firmly packed for nest building, however. Also, her efforts commenced too close to the morning opening of the Japanese Lake area, a time when there is increased traffic by pedestrians and garden work vehicles. The turtle abandoned the attempt after an initial cloacal discharge and perhaps five minutes of desultory scratching in the gravel.

These observations, together with repeated reports by staff members of nesting activities, large groups of hatchlings and the discovery of broken, pliable eggshells in disrupted turf around the lake, suggest that further, more detailed investigation into the breeding activity, incubation and hatching of the turtles of the Japanese Lake may well be worth the effort.

Viewing these turtles affords a unique pleasure that surpasses visits to most of the New York City zoos. When seen in company with resident carp, kingfishers, black-crowned night heron and gray squirrels, the turtles contribute to a seminatural picture of animal life that is very close to the real thing. It is the way it ought to be in any zoo, and it constitutes a zoological feather in the Brooklyn Botanic cap.

Number	Sex	Common Name	Scientific Name	Northernmost Latitude of Wild Habitat
1	?	Common snapping turtle	*Chelydra serpentina serpentina*	Southern Canada
4	2.?	Eastern painted turtle	*Chrysemys picta picta*	Nova Scotia
1	0.1	E. painted intergrade	*Chrysemys picta* x *marginata*	
3	?	Map turtle	*Graptemys* (Species unidentified)	?
1	?	Mississippi map turtle	*Graptemys kohni*	Missouri—Illinois
3	1.2	Peninsula cooter	*Pseudemys floridana peninsularis*	Florida peninsula
22	9.13	Red-eared turtle	*Pseudemys scripta elegans*	Ohio—Iowa
2	1.1	Eastern spiny softshell	*Trionyx spinifer spinifer*	Lake Champlain (Vermont)

Roses and the dreaded blackspot

DON'T USE SCARE TACTICS!

Cynthia Westcott

From The American Rose, January 1973

Generations of rose growers have been strongly admonished to clean up all fallen leaves to prevent spread of blackspot. That advice is almost useless, and cruel to boot. It scares people, making them think that you cannot have roses without all that backbreaking labor.

Rosarians who advoeate cleaning up fallen leaves apparently do not know that the fungus also lives over the winter in small, unnoticed *cane* lesions. There is nothing new about this knowledge. Way back in the 1929 *American Rose Annual* there is a photograph (illustrating an article by Dr. L. M. Massey and myself) showing 'Los Angeles' with numerous dark lesions all over the canes. Mueh later, research by the USDA (sponsored by the American Rose Foundation) showed that the then-recommended dormant lime-sulfur spray had little effect, but that pruning the canes close to the ground did greatly retard the development of blackspot.

Having spent a lifetime controlling blackspot in my own and clients' gardens, I can guarantee that with *proper* summer spraying you don't have to worry about fall cleanup or dormant spraying or other unpleasant tasks. In the summer of 1971 I was too disabled to even superintend the spraying of my rose garden. With no treatment blackspot was rampant (almost 100 percent) by the end of the reason. Nothing was done in the fall, but by May, 1972, I had recovered enough to mix sprays and to instruct a young high school girl in the use of a hose-end sprayer; the kind with a deflector to reach the underside of foliage. We managed to get the sprays on fairly regularly, mostly every week, and obtained almost complete control of blackspot. We used Phaltan as a fungicide, mixed with Isotox as an insecticide-miticide, but the specific chemical is not so important as regularity of application and completeness of coverage. Some have had good results with Benlate, some with maneb, and for years I used an ammoniacal copper with great success.

When I worked as a plant doctor, I was often called in at the end of the season by someone whose roses were defoliated while a neighbor's garden, under my care, was disease-free. The new client expected me to work some magic in September to prevent disease the next year. I never could and I never did anything until spring when I started the regular spraying routine. I did not always get complete control the first year, especially if new roses came in with cane lesions, but blackspot was usually entirely cleaned up by the second season. One September the Penn-Jersey District of the American Rose Society had a convention in my area and I arranged a bus trip to five of my clients' gardens. I offered a dollar to anyone who could find a single leaf with blackspot and I did not have to pay up.

Of course, I do not mean to imply that you should not use reasonable sanitary measures. If you have a few spotted leaves early in the season, it makes sense to remove these before rain can spread spores to nearby bushes. It does not make sense, however, to go through your bushes looking for diseased leaves (or Japanese beetles) while the foliage is wet. This only spreads spores at a favorable time for infection. If you wait until there is widespread spotting, it will not help to remove all such foliage and you are reducing the food-manufacturing surfaces needed to keep that bush through the winter. Just relax, save your back, and vow to do a better spraying job next year.

(Continued)

A shrub rose of durability and great beauty is *Rosa moyesii* 'Nevada'. Its single white flowers are large and borne in abundance and there is a generous amount of repeat bloom.

Marjorie J. Dietz

Need for Winter Protection?

The necessity of winter protection is another myth in many areas. It may be needed in the more northern states and at high altitudes, but in the Middle Atlantic states it is an arduous chore that can be avoided. When I started growing roses in New Jersey, in 1933, I believed the "experts" and nearly killed myself lugging around soil for my clients' bushes every autumn. So I experimented with the roses in my own test garden, which had duplicate beds with the same varieties for comparison. If there was any difference in spring it was in favor of bushes left unhilled over winter. The next season I mounded half the beds at the Montclair Garden Center with soil brought in from a vacant lot next door, and on the other beds merely left the summer mulch of buckwheat hulls. There was no difference in winter survival, but that summer the beds that had been hilled had vastly more weeds from seed brought in with that soil. I have never again hilled up a rosebush; except, of course, immediately after they have been planted.

When I retired and moved forty miles north of New York City, I continued this no-work policy against some local advice. In the past eleven years I don't think I have ever lost a bush due to winter weather. I have lost some from chipmunks feeding on roots in winter (in some regions, both pine and field mice feed on roots), and I have lost a few from crowding or planting too near tree roots or in too much shade, but never from cold. I always say that the best winter protection is a bush kept strong and healthy by summer treatment for disease and pest control. Spraying is preferable and is not hard with a hose-end spray gun, but if that is too much trouble, a light rotary duster is very easy to operate and fairly effective.

People are afraid to grow roses when we emphasize such chores as cleaning up all fallen leaves and lugging around soil for winter protection. Roses are tough. Let's keep rose growing a pleasure and not scare away would-be converts.

Eva Melady

MARSH GARDEN—RAISES TOMATOES AND HYDRANGEAS

Linda Waller

From THE GARDENER, November-December, 1973.

THE MARSH may be home for snakes and mosquitoes, but in one area of Cromwell Farm they're making room for pine trecs, an assortment of flowering shrubs, and even some tomato plants.

Fred Heutte, onetime director of the Norfolk, Va., Department of Parks and Recreation and first vice-president of the newly organized Men's Garden Club of Tidewater, Va., is spreading his home garden right down into the marsh that edges much of his property on the North Branch of the Lafayette River.

He has been experimenting with the marsh garden since his retirement as director of the Norfolk Botanical Gardens seven years ago.

"There are million of acres of marshland all up and down the coast that could be used," he said, claiming that his main interest in the project is ecological.

"The water reservoir all over the country is depleting 6 inches a year on the average," he said, quoting statistics from the U.S. Department of Agriculture. "This is a very alarming thing. What's going to happen 25 years from now?"

Heutte connects his experimental garden with the decreasing water supply because his plants in the marsh never have to be watered.

"Up to 3 feet above high tide you have capillary action and you don't have to water," he said.

Along his sloping marshland, he has cleared a path 3 to 4 feet above the mean high tide. "Anything below this, I never have to water," he said. "Anything above it, I do."

And he claimed that sea water should be preferred over freshwater if it can be used at all. "There are more elements

in sea water that are good for plants than in freshwater," he said.

Heutte has been experimenting with the hundreds of varieties of plants that he grows in his yard to find out just which ones will survive in the marsh. But his idea of marsh is not the raw mud and swamp grass of an untended marsh. "If I put these plants in the marsh grass, they wouldn't grow," he admitted. "They can't grow in the mud. They must have a foot or more of soil."

Tomatoes in the Marsh Landscape

Twenty-five years of throwing the yard clippings from a very prolific garden out into the marsh have given much of the swamp bottom a rich covering. Heutte now has a shredder that grinds leaves, sticks, and even cardboard boxes into usable mulch.

"I never put a pound of soil or a pound of fertilizer out here," he said, standing on the rich damp ground.

The unfinished garden creeps down into a crescent-shaped marsh that is mostly edged by Heutte's two acres of land. A large pile of decaying branches and twigs sits between the garden and the marsh grass.

"In the next five years all this rubbish will decay," said Heutte. "I'm going to landscape all of this eventually."

In what at first looks like 2-foot-tall pots, but turn out to be pieces of terracotta flue pipe, Heutte has staked tomato plants.

"They're just ordinary tomato plants and they do beautifully down here," he said. In fact, they beat out the plants in his yard which were bought at the same time but had been planted two weeks earlier.

"You might say the ones in the marsh were the runts of the litter, but they had tomatoes on them before the others," he said.

Since there is no bottom in the pipes which stick up vertically from the ground, the plants draw water from the marsh bottom as though they were planted right in the soil.

A Place for Hydrangeas

Hydrangeas are similarly planted in plastic chemical drums that have the bottoms cut out. In among the tomato plants and hydrangeas, Heutte has stuffed a few red petunias to brighten the scene.

All other members of the marsh garden, including additional hydrangeas, are planted directly in the ground.

Orange day-lilies add more color to the marsh, and Heutte pointed out that these plants find marsh life so agreeable that they have resown themselves at another spot in the low ground. Narcissus planted in the marsh call out spring in shades of yellow, followed by pink and white rhododendron. The native hibiscus adds more pink to the late summer and the native baccharis shows off its fluffy white seed pods in September. Both of these are natural marsh plants and can survive as far out as the marsh grass.

The bright red flowers of the cardinal plant, normally found wild in cooler areas of Virginia, bloom in September. Heutte is especially excited about this plant since he had several in the garden around his house which had not grown too well and finally died out. Last summer he discovered that they had reseeded themselves in the marsh and are growing beautifully.

Camellias add pinks and whites during the cooler months though Heutte admits they have some limitations in the marsh. "Those that grew down at the one-foot level didn't do too well," he said. "But the ones planted 18 inches to 2 feet above the water line are doing fine." He noted that rhododendrons similarly need to be planted more than just one foot above the mean high water.

Heutte has also had success in his marsh garden with yucca, yaupon, holly, pampas grass, fig trees, ground juniper, magnolia, aucuba, sedum, and pittosporum.

"I've planted native pines, but they won't grow here. The Japanese or black pine will," he said, pointing to one in the marsh about a foot above the water line.

Marjorie J. Dietz

Several gesneriads are prospering and blooming in this small terrarium (14 inches long) kept in a city apartment window. Included are sinningia 'Doll Baby' and 'White Sprite'.

GROWING GESNERIADS IN TERRARIUMS

William L. Donnelly, M.D.

From Long Island Horticultural Bulletin

The terrarium supplies tropical plants with a humid, warm environment that is most like their native habitats. Terrariums can be made in any size, put in almost any place in the home, and require a minimum care once they have been properly set up. They can be attractive to look at and as a hobby can be most satisfying.

A terrarium can be made of almost any transparent container such as a fish tank. But cider bottles, large jugs, brandy snifters, or almost any jar or bottle can be used. Since fish tanks come in many different sizes, one can usually be found to fit the area you want it to occupy. Many stores also now sell the popular "buddle bowls," large, round glass globes which also make excellent terrariums. The terrarium should be cleaned and rinsed thoroughly and soaked if possible in a solution of 1 part Clorox to 9 parts water for six hours and then thoroughly rinsed again.

Various soil mixes can be used. Humus lightened with Envee in a 2-to-1 mix is excellent. Vermiculite, peat moss, and perlite in a 1-1-1 proportion is also good. Whatever you use should be sterile and weed-seed free or you will have diseases and weeds galore.

The plants selected should all be small in size. Large plants will soon take over the terrarium and make a jungle. Many of the miniature gesneriads are ideal plants for a terrarium. Small kinds of *Sinningia,* under the right conditions, are almost everblooming: 'White Sprite' has perky white flowers, 'Concinna' has lavender flowers with purple freckles in the

throat, 'Bright Eyes' is a robust little hybrid with lavender flowers similar to the older *Sinningia pusilla,* but a little larger. Other sinningias are 'Freckles' and 'Doll Baby' which are a little larger but still of terrarium size. These all grow from tubers so if they become a little ragged, they can be cut down to the soil and will soon sprout again. The gesnerias are delightful with their shiny serrated leaves. *Gesneria cuneifolia* has fire-cracker-red flowers, *Gesneria citrina* has pure yellow flowers and *Gesneria quabradallis* has orange- and yellow-striped flowers. All the gesneria species are slow growers that thrive in a humid atmosphere. They bloom almost continuously if you remember to cut off the seed pods. Other gesneriads suitable for terrarium growing are: *Achimenes erecta* which is an achimenes of small size; *Boea hygroscopica*—loves humidity but it may grow a bit large—put it in the back of the terrarium. *Codonanthe carnosa,* also good; *Hypocyrta nummularia*—a small-leaved trailer as opposed to the usually large hypocyrtas; *Episcia dianthiflora,* small leaves and fringed white flowers—a delightful plant; *Streptocarpus cyanandrus* and *S. rimicola,* small enough to use; *Phinaea multiflora,* can also be used; *Diastema vexans,* a small growth habit with tiny white and purple flowers. All of these plants are available from any gesneriad dealer and all will grow beautifully in terrariums.

Slope your soil mix to the back and plant your taller plants there and your smaller plants toward the front. Water the soil with a fertilizer such as Rapid-Gro in half-strength to get the soil moist. Take out of your terrarium any excess water by pouring or using a baster. Further watering may not be necessary except after long intervals and then be careful not to over-water. Cover the terrarium with glass or Saran Wrap.

Lighting can be done by window light but never in direct sunlight except for early morning sun, else all your plants will be cooked! Better still, use fluorescent fixtures—the size depending upon the size of the tank. Two 24-inch tubes are about right for a 20-gallon fish tank. Set up your tank as directed, put on a timer to keep the lights on about 16 hours a day and off 8 hours and you will have a delightful display of the healthiest plants you have ever seen.

If you like variety you can add other plants to your gesneriads. For example, there are many miniature begonias. You can also add small ferns, mosses, baby's-tears or whatever miniature plants that suit your fancy. As time goes on and the plants get too large, remove them and replace with smaller different varieties. Enjoy the beauty of a year-round tropical jungle which looks beautiful at all times, but especially so under fluorescent lights. You can even add rocks, driftwood or other appropriate items to add charm and atmosphere.

Beating Fertilizer Costs

From News & Views, American Horticultural Society, April 1973

MODERN commercial fertilizers are far more efficient than the old-fashioned animal manures, but they keep increasing in cost with the various choices of additives. You will find that you can greatly reduce your cost by using plain farm fertilizer—a 12-12-12 or a 15-15-15 which you should be able to find at any farm elevator. Being granular, they are easy to scatter by hand, and they don't cling to (and thereby burn) plant foliage. Since plants cannot read, they won't know that the bag doesn't specify that it's for roses, ferns, wildflowers, garden flowers, trees, shrubs, evergreens, or ground covers. Besides, it doesn't make any difference.—*Victor H. Ries*

WHAT'S NEW IN BIOLOGICAL CONTROLS

Charles C. Doane

From HORTICULTURE, June 1973

POSSIBLY you are suffering from the pesticide syndrome. You probably are if you spray insecticides on your plants by the calendar rather than whether insects are present or not. Sometimes in our effort to control insects we tend to forget that many pests or potential pests in our surroundings are already under suppression by introduced and natural microbes, insect parasites or predators. Our efforts would be puny, indeed, without the great contribution of biological control agents.

For example, the Japanese beetle reached its peak in the Northeast in the early 1940's. Infestations of grubs destroyed many lawns. Dead turf could be rolled back to expose from 100 to 300 grubs in a single square foot. Adult beetles, by skeletonizing leaves, defoliated a wide number of tree species. Blossoms of roses and other flowers were completely consumed during the day.

About 30 years ago the bacterium *Bacillus popilliae*, causing milky spore disease in the grubs, was first propagated and applied to turf in Connecticut. In the beginning the disease seemed unlikely to stem the tide and was considered a failure. Actually, the spores were spreading steadily to new infestations and by the end of the 1950's were well distributed within the range of the beetle population. Adult beetles no longer appeared in such devastating numbers and widespread defoliation was no longer as serious a problem. Localized infestations were still present, but larval density, as R. L. Beard found, was at most about 20 larvae per square foot and most of these were infected. Such larvae died before reaching the adult stage leaving in the soil countless numbers of longlasting spores that prevented new infestations from developing.

Japanese beetles have been moderately troublesome in some localities of Connecticut during the past decade, but there can be no doubt that the introduction of milky spore disease was an outstanding success. The bacterium continues to prevent development of beetles over large areas and we can scarcely imagine what the beetle population would have been without this disease. *Bacillus popilliae* dust is commercially available and there may be locations where artificial distribution of spores is still beneficial as in new housing developments where spores are not present in the lawns.

While viruses, bacteria and other pathogens commonly control pest populations at the peak of the outbreak, it is unusual to find a single parasite capable of doing this. Yet, this is happening with a chalcid wasp, *Ooencyrtus clisiocampae*, first reported by J. Anderson and H. Kaya as an egg parasite of the elm spanworm or snow-white linden moth.

In 1970 and 1971 the spanworm reached peak abundance in southwestern Connecticut and southeastern counties of New York where thousands of acres of woodland were defoliated. The wasp, which is capable of destroying practically all the viable eggs in the egg mass, first brought the spanworm under control in Fairfield County where less than 2 percent of the eggs escaped attack during 1971. The parasite has now spread into the newer outbreak areas and appears to have brought this defoliator under control throughout most of the state.

Usually the effects of a single parasite are not so dramatic, however. Often a complex of parasites and predators is necessary to suppress potentially destructive populations of insects. However, the complex attacking the gypsy moth is only partially effective and does not prevent outbreaks of this introduced defoliator. It is notable that the first importations of the parasites and predators making up the complex began in 1905 and have continued intermittently until the present.

Marjorie J. Dietz

Clusters of the tan felt-like egg masses of the gypsy moth at the base of an oak trunk. It has been discovered that deer mice, attractive light brown and white in color, relish gypsy moth eggs as winter feed, affording a modest natural control of the gypsy moth population.

Recently W. W. Metterhouse and representatives of the USDA and state experiment stations have renewed attempts to establish newly imported parasites, some of which failed to establish earlier. Any of these new importations may markedly increase the potential of the predator-parasite complex for suppression of the gypsy moth with the result that serious outbreaks occur less often.

To date, the most effective natural biological control agent in dense populations of the gypsy moth is a nuclear polyhedrosis virus that causes wilt disease. Research on this virus is also in progress with the expectation that we may be able to manipulate the virus to prevent outbreaks of the gypsy moth.

The delay in finding highly effective parasites of the gypsy moth, however, should not be interpreted to mean that none will be found. The California red scale, for example, was introduced into California between 1868 and 1875 and rapidly became a major pest of citrus. Efforts to introduce its natural enemies from China began in 1889, but for 50 years all attempts failed. Finally in 1948 a very effective parasite from China was established. The earlier attempts had failed largely because the taxonomy of scales was confused and the real parasites of the red scale were not recognized.

In the past most viruses have been utilized for biological control by simply releasing them into an uninfected host population where they spread naturally and maintained themselves. These viruses are usually passed from one generation of the host to the next and are most effective in attacking dense host populations. In the past, federal registration has not been necessary for viruses released in this way. Now, however, there is much interest in applying certain viruses directly for insect control, but their development will be slowed by the extensive requirements necessary for federal registration before they can be sold commercially.

One under consideration is a nuclear polyhedrosis virus of the cabbage looper. This virus occurs naturally and the bodies of approximately 10 virus-killed larvae mixed with water and sprayed over foliage of an acre of cabbage will control the infestation. R. P. Jacques has found control with the virus equal to or better

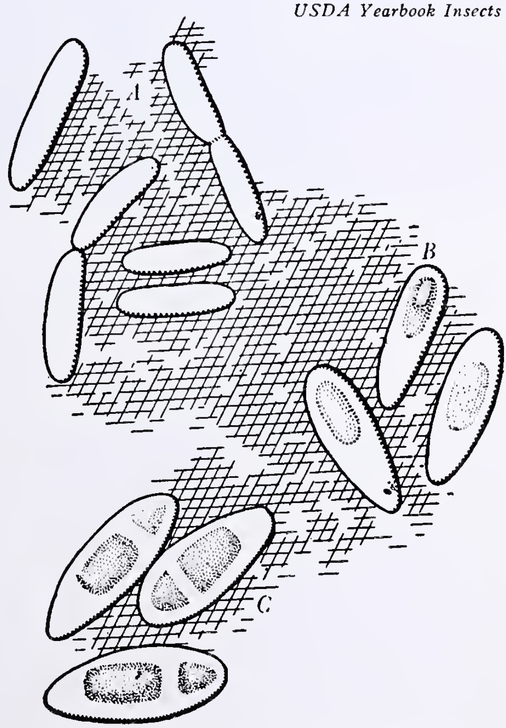
than that obtained with chemical applications. One application of the virus gave seasonal control equal to several insecticide applications because it reproduced itself in the caterpillars. Further, the looper infestation was controlled not only throughout one season but also the year following by an application to the soil around the cabbage. Like other viruses it is specific for only one or two hosts and is harmless to vertebrates and other insects including the beneficial ones. Such viruses when widely available will likely be an important part of the arsenal of the gardener.

Bacillus thuringiensis, often termed a microbial insecticide, is now available for control of many caterpillar species. It is safe to almost all non-target insect species as well as fish and wildlife and may be applied on food plants up to the day of harvest. However, it does not spread naturally or maintain itself in outdoor populations. So, like chemical insecticides, it must be applied as the need arises.

It is a bacterium toxic only to moth and butterfly larvae. Upon ingestion, toxic crystals in the preparation cause stomach paralysis and the caterpillar ceases to feed. Many loopers die in one to three days, although some remain alive longer. *Bacillus thuringiensis* is registered for the control of a number of pests, including cabbage looper, corn earworm, European corn borer, tomato hornworm, fruit-tree leaf roller, spring and fall cankerworms, linden looper, gypsy moth and tent caterpillar.

Natural biological control is always at work, although the gardener who has just found an infestation on a favorite plant may not put much faith in it. Practitioners of biological control above all else must be naturalists with the philosophy that natural control forces are most effective and that insecticides are used only as a last resort.

USDA Yearbook Insects



Milky disease spores. **A.** Vegetative rods (the form of the disease as it grows and multiplies in blood of Japanese beetle grub). **B.** Sporulating rods which soon develop into mature spores **(C).** The spores are about 1/4600 inch long and several billion may exist in one grub. The disease causes the blood of a sick grub to look milky. After the grub dies, the spores remain in the soil, ready to attack other grubs.

A countryside without wild plants?

PLANTS—INTERNATIONAL TRAVELERS

Margo W. Reynolds

From Horticulture, January 1974

Well-worn country roads or sleek super-highways bare of volunteer vegetation? They would be drab indeed without the familiar and ubiquitous patches of yellows, golds and shades of white that identify, often from a considerable distance, the unpretentious and oft-maligned yarrows, ox-eye daisies, Queen Anne's-lace, chicory and other common plants.

Hard put as we might be to imagine the countryside without them, there are few people who realize how many of these are not natives. These plants and others like them have made themselves welcome in ever more extensive areas of the country in the last few centuries. Most are growing where they are as unbidden, unsolicited and sometimes unwanted squatters.

At one time some of them were desired plants, highly regarded as garden flowers and potherbs, medicinal and culinary plants—escapees from gardens. In their new homes they flourished, quickly escaping cultivation and spreading into new areas where they soon became common weeds over much of the landscape. Still others made their way here without the intentional hand of man.

One of the earliest of these plants brought to North America by the colonists was purslane (*Portulaca oleracea*). Introduced as a potherb, this relative of the attractive portulaca of flower borders was cultivated for some time as a food. The tender shoot tips and fleshy green leaves of this prostrate plant were cooked and served like spinach.

The settlers' westward expansion across the country was one of a number of changes that enabled vast numbers of plants to migrate. The common plantain of lawn and vacant lot was one of many that traveled westward on the heels of man.

As trees were felled and land was cleared and plowed the face of North America changed dramatically. It was not long before plants began moving into the newly-opened areas. Many of the plants that migrated extensively in this country have become serious pests, overrunning vacant lots, prime agricultural land and countryside alike with indiscriminate abandon.

Many have spread almost entirely by their own efforts with assists only from Mother Nature. Whether advancing by seed, creeping rootstock or other means, they have often distributed themselves over vast areas with amazing rapidity.

Effective seed dispersal is one characteristic that most successfully migrating plants share. Many, such as the cocklebur, burdock and stick-tight, produce seeds with barbs, hooks or similar projections which enable them to cling to a person's clothing or an animal's fur.

Other seeds are winged or plumed or as fine as dust particles so gusts of wind easily carry them long distances. The same wind just as easily deposits them into streams where they float with the current.

Birds are marvelous disseminators of seeds, especially of fruits. Anyone who has noticed the seedlings beneath telephone lines can verify this. Likewise, waterfowl and other migratory birds can transport seeds in mud caked on their feet. When we consider the distances that some birds travel, it is no surprise that many plants have spread so far.

However, seeds are not the only means by which plants manage to get themselves to other locations. Plants possessing horizontally spreading root systems or prostrate stems that root vigorously at the nodes are energetic travelers. The field bindweed (*Convolvulus arvensis*) is a

Judy Sugar

The seed head of a dandelion, waiting to be dispersed by a puff of wind or by contact with humans or animals, is shown above. Gill-over-the-ground (*Glechoma hederacea*), growing with the dandelion, is a widely naturalized Eurasian plant, considered a desirable ground cover—or a weed—depending on one's point of view.

prime example of a plant that has managed to increase its geographical area by means of a highly effective root system.

Plowing a field of bindweed is a sure means of helping this plant spread. Almost any portion of root scattered by the plow is capable of producing a new colony. Also, fragments may retain their vitality several years and are capable of sending up as many as 300 new shoots.

Man has brought many plants to this country for the purpose of cultivating them. The tall buttercup (*Ranunculus acris*), was considered a rare and exotic ornamental when it was introduced into a garden in western Washington in 1919. By 1929 local farmers began noticing a peculiar yellow weed in their pastures and puzzled over its source. By 1932 *R. acris* had migrated so successfully that botanists included it in the flora of Washington. Today, this escapee is found from Alaska to Labrador and south at least as far as Virginia.

Another intentional introduction was purple loosestrife (*Lythrum salicaria*).

This Eurasian plant was regarded as an ornamental of particular value in moist, wet locations where its tall, showy spikes of purplish hue could provide a brilliant display in late summer.

Unfortunately, the migration of the plant within this country following its much-heralded introduction progressed at such an alarming rate that today it threatens to choke out vast areas of, in some cases, rare and valuable native vegetation. In 1848 loosestrife was confined primarily to some wet meadows in Maine, eastern Massachusetts and Orange County, N.Y. By 1889 it had become naturalized from Nova Scotia to Delaware. Today it is common in the northwestern, central and northeastern sections of the country.

Frequently, man's role in the migration of plants has been wholly unintentional. His armies have distributed seeds to countless foreign soils. Roman foot soldiers are believed to have introduced a number of Mediterranean plants to Britain during the expansion of their empire. Seeds commonly travel from place to place as impurities in agricultural grain, in hay and livestock feed, in packing materials and wedged into the cracks of cartons and crates.

In the days when transportation of people and goods was primarily by ship, especially sailing ships, many plants were accidentally carried to distant parts of the globe. It was a common practice to shovel tons of soil or similar material aboard the ships to provide extra ballast so that ships sailing light of load would ride better. One can only guess at the number of Old World seeds that booked passage to far-away places in this manner.

It does not require much imagination to picture untold numbers of European seeds crossing the Atlantic in soil kept moist and cool in the darkness of a ship's hold. When the ballast was shoveled out at some dock in New York, Boston or Virginia all that was needed was several days of warm sunshine before the seeds would begin to germinate.

In addition to all these we have those which did not depend upon man or animal in any way to get around. A good example is the coconut, which floated its way to just about every tropical and subtopical land in the world.

Preventive Weed Control

WEEDS have been defined as "plants for which a virtue has not been found." Weeds in gardens are problems for aesthetic reasons, and because they compete for space and light with cultivated plants. Also, they can serve as alternate hosts for insects and diseases. Moreover, they deplete the soil of water and nutrients which would be available otherwise to desirable plants.

There are several ways to control weeds. The coming years may even see fruitful research on some sort of biological control. One technique under investigation is to infect weeds with a specific microorganism.

However, one of the most important—and overlooked—methods is still preventive weed control. This includes all the measures taken to prevent the introduction of weeds to the garden. Seeds and nursery stock should be from reliable, well-maintained establishments. Consideration should be given the origins of any straw, manure, bark mulch, compost and sawdust used in the garden, since they may contain weed parts or weed seeds. Mulching is a widely used practice to prevent weed problems. Several materials such as plastic film or the above materials are used for this purpose. Generally the best policy is to prevent the spread of weeds; it is said that one year of seeding equals seven years of weeding.—*Thomas Pollak*

BIOLOGICAL CONTROL OF RED SPIDER

K. M. Harris and A. J. Halstead

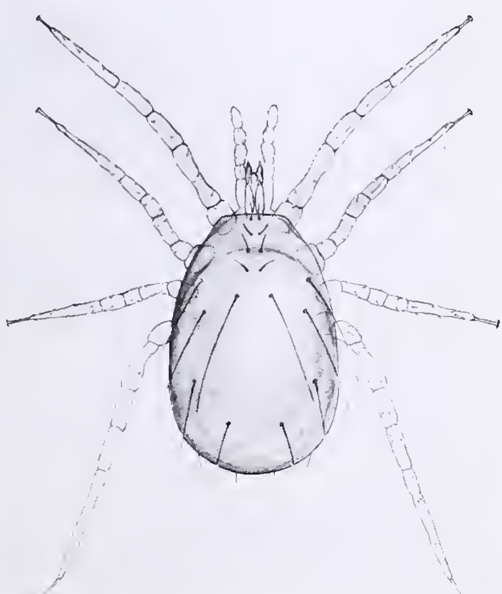
RED SPIDER MITES (*Tetranychus urticae*) are a major pest in both home garden and commercial greenhouses. Their control is not easy. Many of the more effective pesticides are unavailable to home gardeners due to the highly toxic nature of these compounds. Even their effectiveness is short-lived, as the mites often become resistant to the chemical after exposure to it for a couple of seasons. When the mites become immune to a chemical, they usually gain resistance to related compounds as well, rendering whole groups of pesticides useless for controlling them.

Red spider mites breed very rapidly under greenhouse conditions and ten or more treatments per season may be necessary for control in a commercial situation. In order to reduce the cost of control and to avoid the problem of pesticide resistance, biologists have developed an alternative means of controlling this pest by introducing a predatory mite, *Phytoseiulus persimilis*, which comes originally from Chile.

In 1959, biologists in the United States, Canada and Holland began investigating the suitability of these mites as biological control agents. They proved to have many useful qualities. As predators they are very active and soon spread over a plant, seeking out isolated groups of prey. Their diet consists entirely of greenhouse red spider mites and closely related species. There is no danger of them attacking plants or beneficial animals and becoming a pest themselves. They have voracious appetites and at their optimum temperature range (75-85°F.), they can breed twice as fast as the red spider mites.

Adult females lay 3-4 eggs a day and at 70°F. these hatch in 2-3 days. After three nymphal stages, the predators become adults 7-9 days later. The nymphs and adults feed on all stages of the red spider mite's life cycle, including the

The predatory mite, *Phytoseiulus persimilis* (drawing greatly enlarged). The mite, a native of Chile, is being advocated as a control of red spider mites, especially in commercial greenhouses devoted to food crops such as tomatoes, cucumbers and strawberries. It can also be introduced into gardens outdoors.



eggs. An adult female may eat about 30 eggs or 24 immature mites a day.

When it is used correctly, *Phytoseiulus* gives better and cheaper control of red spider mites than chemicals. The predator is now being used in the United Kingdom in place of chemicals in some commercial concerns growing cucumbers, tomatoes, strawberries and other plants. It has obvious advantages over chemical control in home garden greenhouses and, to a lesser extent, on plants growing out-of-doors.

Phytoseiulus is very sensitive to pesticides and is likely to be killed by most chemicals used against other pests. If pesticides have to be used, then it is best to use non-persistent materials, such as malathion or nicotine. Some plants which have a good supply of predators on them should be removed before spraying is to take place. The predators can be returned to the other plants after a few days when the effect of the pesticide has diminished.

Phytoseiulus will die out once it has killed off all available red spider mites and in any case may not survive the winter in greenhouses. It may therefore be necessary to reintroduce it every year.

Editor's note: Phytoseiulus is available in the United States from Rincon-Vitova Insectaries, Inc., P.O. Box 95, Oak View, California 93022; Biotactics, 4436 Elora Ct., Riverside, California 92503; in England from Springfield Nursery, Ltd., Pick Hill, Waltham Abbey. The predators will *not* survive on plants devoid of spider mites.

A New Grafting Procedure

A PROMISING NEW WAY of propagating some difficult species has been undergoing extensive trials in Korea.* The technique is based on a type of "inverted root, nurse graft" and has been remarkably successful with chestnuts and large-seeded pines. In its present stage of development, the technique appears to be limited to plants having large seeds which produce a relatively massive seed root. The radicle (the first root produced by the seed) must be large because after cutting off its tip with a sharp blade, it is cleft to accommodate a short dormant scion of the clone to be propagated. The base of the scion is sharpened in the traditional wedge shape and inserted into the cleft made in the seed root. After making certain that the root cleft is in contact with the cambium of the scion on at least one side, the two components are bound together and placed under conditions of high humidity and good aeration to complete the graft union. The completed operation consists of a sprouted seed with a scion apparently growing from the seed root.

The Korean workers report that in a remarkably short time, stock and scion form a firm union. Vascular connections are established between the stock and the scion and lateral roots form on the root stock. The graft union apparently keeps the scion in a healthy condition and it quickly responds by producing scion roots.

The success of this method of grafting appears to be due to the readiness of the "juvenile" tissue of the radicle to form a graft union and to the rapid development of scion roots. Scion rooting eliminates the problem of delayed graft incompatibility which often follows other types of grafting.

—*Leo A. Dionne*

*Research Report of the Institute of Forest Genetics, No. 9, Institute of Forest Genetics, Office of Forestry, Suwon, Korea, July, 1972.

Judy Sugar

Onions are practical vegetables for the home garden. They can be grown from seed (to be harvested as scallions) or can be purchased as seedlings or "sets" to produce good-sized onions for fall harvesting.

For good taste and economy, 1974 is the year for growing vegetables . . .

VEGETABLE SEED SOURCES

WITH CONTINUING INFLATION, the home vegetable garden has been undergoing a revival. Here is a list of firms selling vegetable seeds. All of them have catalogs which are free for the asking, except where noted.

F. W. Bolgiano & Company, 411 New York Avenue N.E., Washington, D.C. 20002

Burgess Seed and Plant Company, Box 218, Galesburg, Michigan 49053

Burnett Brothers, Inc., 92 Chambers Street, New York, New York 10007

W. Atlee Burpee Company, Box 6929, Philadelphia, Pennsylvania 19132; also Clinton, Iowa 52732; Riverside, California 92502

D. V. Burrell Seed Growers Company, Box 150, Rocky Ford, Colorado 81067

Comstock, Ferre & Company, 263 Main Street, Wethersfield, Connecticut 96109

DeGiorgi Company, Council Bluffs, Iowa 51501 (catalog 25¢)

Dominion Seed House, Georgetown, Ontario, Canada

Farmer Mac's, Box 62412, Virginia Beach, Virginia 23462

Farmer Seed and Nursery Company, Faribault, Minnesota 55021

Henry Field Seed & Nursery Company, Shenandoah, Iowa 51601

Glecklers Seedmen, Metamora, Ohio 43540

Gurney Seed & Nursery Company, Yankton, South Dakota 57078

Joseph Harris Seed Company, Rochester, New York 14624

Charles C. Hart Seed Company, Main and Hart Streets, Wethersfield, Connecticut 06109

H. G. Hastings Company, Box 4088, Atlanta, Georgia 30302

Le Jardin du Gourmet, Box 119, Ramsey, New Jersey 07446

Johnny Apple Seeds, Acton, Massachusetts 01720 (list 25¢)

J. W. Jung Seed Company, Randolph, Wisconsin 53956

D. Landreth Seed Company, 2700 Wilmarco Avenue, Baltimore, Maryland 21223

Earl May Seed and Nursery Company, Shenandoah, Iowa 51601

Helen S. Witty

'Bibb' lettuce is one of the salad treats readily grown in the home vegetable garden.

Sorrel is a handsome leafy perennial that can be started from seeds sown in spring.

McFayden Seed Company, Ltd., P.O. Box 1660, Brandon, Manitoba, Canada

Nichols Garden Nursery, 1190 N. Pacific Highway, Albany, Oregon 97321

L. L. Olds Seed Company, Box 1069, 2901 Packers Avenue, Madison, Wisconsin 53701

George W. Park Seed Company, Greenwood, South Carolina 29646

W. H. Perron & Company, Ltd., 515 Labelle Boulevard, City of Laval, Quebec, Canada

Seedway, Inc., Box 14123, Hall, New York 14463

R. H. Shumway, Seedsman, Rockford, Illinois 61101

Silly Seeds, Edmund Scientific Company, 555 Edscorp Building, Barrington, New Jersey 08007

Stokes Seeds, Inc., Box 548, Buffalo, New York 14240; also Box 10, St. Catharines, Ontario, Canada

Otis S. Twilley Seed Company, Salisbury, Maryland 21801

Vita Green Farms, Box 878, Vista, California 92083

OVERSEAS

Ansaloni, Arturo, Bologna, Italy

Clause L. Bretagny, Sur Orge, S. A. France

Sluis and Groot, N.V. Enkuizen, Holland

Sutton and Sons, Ltd., Reading, Berks., England

Tezier Frères, Valance sur Rhône, France

Thompson & Morgan, Seedsmen, Ipswich, England

In addition, many hardware and garden supply stores, even supermarkets, carry seeds from three major companies: Asgrow-Manville Company, Rochester, New York; Ferry Morse Seed Company, Mountain View, California; Northrup King Company, Minneapolis, Minnesota.

A Horticultural Therapy Council

CONSIDERABLE INTEREST has been generated in the past few years to put horticulture to work in hospitals and other institutions. Recently, leaders in this field have banded together to form the National Council for Therapy and Rehabilitation through Horticulture. Among its purposes is to serve as a national clearing-house of information on this subject. The first annual meeting was held November 5-6, 1973 in Washington, D.C. For further details about this membership organization write to the Secretary, 5606 Dower House Road, Upper Marlboro, Maryland 20870.

Marjorie J. Dietz

In this home vegetable garden, spinach has been planted between two rows of leek. The spinach, a quick-maturing crop, is harvested long before its space is required by the leek plants which need a full growing season before they reach maturity in late fall.

Gottscho-Schleisner

Garlic chives (*Allium tuberosum*) is both beautiful and useful. Its strap-like foliage is chopped and used in the same ways as are chives. It is also popular in oriental cuisine.

The brilliant scarlet flowers on tall spikes make the cardinal flower one of the most spectacular of native perennials.

Gottscho-Schleisner

SEEDS AVAILABLE TO MEMBERS

THE BROOKLYN BOTANIC GARDEN is pleased to announce another seed dividend this year for members who would like to try a few choice, out-of-the-ordinary kinds of plants in the home garden. The seeds will be shipped fresh in autumn, providing there is a good harvest, and will be accompanied by sowing and growing directions. Kindly send a stamped, self-addressed envelope to the Editor if you want to share this bounty from Brooklyn. If you do not belong to the Botanic Garden, particulars on Membership are available from Mrs. Norman Free, Brooklyn Botanic Garden, 1000 Washington Ave., Brooklyn, N.Y. 11225. Here is the dividend:

Garlic chives (*Allium tuberosum*). Ornamental kitchen herb growing about 18 inches tall. Stalks of white flowers appear in the latter part of summer and are effective for a month. The strap-like leaves of this perennial may be chopped like chives and served in a salad or with baked potatoes and sour cream. Winter-hardy to Zone 4 (Arnold Arboretum map).

Hardy rubber-tree (*Eucommia ulmoides*). A rare tree from central China, growing to 45 feet or more. Old specimens grown in the open are usually broad-branched and as wide as tall. All part of *Eucommia* contain rubber, which may be seen by gently pulling a leaf apart, but attempts to use the tree as a rubber-substitute have not been commercially feasible. Hardy to Zone 5.

Golden-rain tree (*Koelreuteria paniculata*). Upright tree to about 30 feet. The sinuous branches have a fine winter effect and the yellow flowers, which appear in clusters, are striking in summer. Refined compound leaves. The tree grows well in New York City. Hardy to Zone 5.

Cardinal flower (*Lobelia cardinalis*). Splendid wild flower of the eastern U.S., growing 2-4 feet tall. Brilliant red flowers, in spikes, occur from late July to September depending on climate. Although found in nature in moist places, this usually short-lived perennial can be grown under normal garden conditions. More-or-less hardy to Zone 2.

1973 BOOKS WORTH NOTING

In the Library of the Brooklyn Botanic Garden

(Please order directly from your bookstore, not from the Botanic Garden.)

Arrangements

Flowers and Foliage by Nora Fields. A. S. Barnes and Company, South Brunswick (New Jersey) and New York. $15.00

Photographs of 130-or-so of the author's contemporary arrangements, many of them influenced by Ikebana and all of them having a pleasing absence of clutter. She discusses materials and techniques, and one chapter attempts to tell how to enjoy floral creations.

Plant it Now, Dry it Later by Harriet Floyd. McGraw-Hill Book Company, New York. $12.95

Dried arrangements from garden and roadside plants. Suggestions for a "dry" garden. Techniques of drying. Well researched.

For the Coffee-Table

The Forest, edited by Walter Kümmerly. Robert B. Luce Company, Inc., Washington, D. C. and New York. $25.00

A world-wide treatment by a noted Swiss cartographer. A fine overview with many good photographs.

The International Book of Trees by Hugh Johnson. Simon and Schuster, Inc. $29.95

A big, brassy volume with numerous color photographs of trees of temperate climates. Descriptions and charts. Attractively done.

The White House Garden by Frederick L. Kramer with color plates by Harold Sterner. Great American Editions, Ltd., New York. $19.50

A bit of history, some flowers and floral arrangements.

Greenhouse

Gardening Under Glass by Jerome A. Eaton. The Macmillan Company, New York. $8.95

How to set up and care for a home greenhouse. Pleasurable routines and desirable plants. A fine introduction to this subject by a leading practitioner.

Greenhouse Gardening by Henry T. and Rebecca T. Northen. Second edition. The Ronald Press Company, New York. $9.50

A welcomed updating of a solid reference book. The authors discuss principles, desirable plants to grow, and pests.

Herbal and Medicinal

A Guide to the Medicinal Plants of the United States by Arnold and Connie Krochmal. Quadrangle/The New York Times Book Company, New York. $9.95

Descriptions, illustrations and traditional uses of 272 plants, with the emphasis on Appalachian "yarbs." Some are still used in drug manufacture, but the authors caution against home remedies.

A Guide to Natural Cosmetics by Connie Krochmal. Quadrangle/The New York Times Book Company, $8.95

Trash Bag Composting

From THE AVANT GARDENER, June 1, 1973

EASY "anywhere" composting has been made possible by plastic bags. The 32-gallon garbage can liners are especially useful in the fall when garden debris and leaves are so plentiful. A couple of shovelfuls of plant wastes are put in the bag and sprinkled with fertilizer and lime (omit the lime if making compost for acid-soil plants). This is repeated until the bag is full, then about a quart of water is added and the bag is tied tightly. Fast decomposition, space saving, and no need to turn the "heap" are advantages of this method—and the bags can be stored in the cellar or heated garage where cold will not slow the composting action.—*Betty and Thomas Powell*

Herbal recipes for perfumes, face preparations, soaps, and even toothpastes. Source lists. Well researched.

Potpourris and Other Fragrant Delights by Jacqueline Hériteau. Simon & Schuster, Inc., New York. $4.95

How to bring fragrance into the home by mixing spices and flower petals. Numerous recipes and a source list of materials for this old-time art.

Indoor Gardening

The Beansprout Book by Gay Courter. Simon and Schuster, Inc., New York. $2.95

Details of a burgeoning little hobby among health-food enthusiasts and fanciers of Chinese cooking. The author, with the aid of illustrator Lorraine Bodger, tells how to sprout mung, alfalfa, lentil and other seeds in the kitchen, and gives a few recipes. Source list.

Beginner's Guide to Hydroponics by James Sholto Douglas. Drake Publishers, Inc., New York. Soft cover, $2.95

The fascinating hobby of growing plants without soil.

Exotic House Plants by Alfred Byrd Graf. 8th edition. Roehrs Company Publishers, East Rutherford, New Jersey. $7.50

For the average house-plant buff this is probably Mr. Graf's most serviceable book. The 1,200 photographs are a valuable aid to identification. Cultural keys.

House Plants by Joan Compton. Grosset & Dunlap Publishers, New York. $4.95

A sound, concise guide that will be especially useful to the new gardener. Choice kinds of house plants, their care and arrangement. Glossary and a list of further readings. Henry Barnett's drawings are a joy.

Houseplants and Indoor Landscaping by Muriel Orans. A. B. Morse Countryside Publications, Barrington, Illinois. Soft cover, $3.95.

Well-balanced introduction to a currently popular subject. Numerous color photographs by Arthur Orans.

Houseplants are for Pleasure by Helen Van Pelt Wilson. Doubleday & Company, Inc., Garden City, New York. $7.95

Seldom a year passes without a book or two from this garden writer. House plants are one of her continuing interests and in this one she discusses her experiences with many kinds. A month-by-month grower's guide is included.

Plant Consciousness, Plant Care by Shirley Ross. Quadrangle/The New York Times Book Company, New York. $7.95

The first part is devoted to mystical anecdotes, the second to a few elements of house plant culture. Readers who believe that plants have feelings will like this book.

The New York Times Book of House Plants by Joan Lee Faust, Quadrangle Books, New York. $9.95

Basic care, descriptions and illustrations of over 150 kinds. Also, chapters on gardening under lights, office plants, bottle gardens and propagation. The author is garden editor of The New York Times.

The Terrarium Book by Charles M. Evans with Roberta Lee Pliner. Random House, New York. Clothbound $7.95, paperbound $3.95

Brief, helpful text and good illustrations. Techniques and plants to try.

Landscaping

Color for the Landscape, edited by Mildred E. Mathias. California Arboretum Foundation, Inc., et. al., Arcadia. $9.35

Descriptions and color photographs of the many subtropical plants grown in the milder parts of California.

A Distinctive Setting for Your House by Alice Upham Smith. Doubleday & Company, Inc., Garden City, New York. $8.95

Topography and house design occasionally leave something to be desired, but this landscape architect has a variety of plans to make the most of the particular situation. Condominiums and mobile homes, as well as the traditional types of dwellings, are covered. Well illustrated and geographically balanced.

The Garden Art of Japan by Masao Hayakawa. John Weatherhill, Inc., New York and Tokyo. $8.95

Many kinds of Japanese gardens exist. The history and philosophy of them is traced in this well-illustrated work.

The Gardener's Basic Book of Trees & Shrubs by Stanley Schuler. Simon and Schuster, Inc., New York. $9.95

Helen Van Pelt Wilson's Own Garden and Landscape Book by Helen Van Pelt Wilson. Doubleday & Company, Inc., Garden City, New York. $7.95

Landscaping and the Small Garden by Marjorie J. Dietz. Doubleday & Company, Inc., Garden City, New York. $7.95

Advice for the new homeowner on planning and planting the quarter-acre property. Desirable plants. Chapters on terrace gardening, low maintenance and hobby gardens. The author is Associate Editor of PLANTS & GARDENS.

Miss Jekyll by Betty Massingham. David & Charles Publishers, Newton Abbot, England. £3.50

Biography of Gertrude Jekyll (1843-1932), one of England's great gardeners—and garden writers. Revision of a 1966 book.

A Perfect Lawn The Easy Way by Robert W. Schery. Macmillan Publishing Company, New York. $8.95

Excellent down-to-earth advice by one of America's leading turf authorities. A revision of an earlier book.

Miscellaneous

False Prophets of Pollution by R. Milton Carleton. Trend House, Tampa, Florida. Soft cover, $3.95

Outspoken, at times angry attack on a variety of recent environmental measures, including the banning of DDT.

Growing Up Green by Alice Skelsey and Gloria Huckaby. Workman Publishing Company, Inc., New York. Clothbound $8.95, softbound $4.95

Suggestions for children's gardening projects.

Seed to Civilization by Charles B. Heiser, Jr. W. H. Freeman and Company, San Francisco. Clothbound $7.50, paperbound $3.50

The fascinating story of rice, hybrid corn, wheat and other food plants we aren't going to take for granted much longer. Especially recommended.

Plant Groups

Bromeliads by Victoria Padilla. Crown Publishers, Inc., New York. $12.50

The most comprehensive book on the ornamental kin of the pineapple. Fine color photographs, some of them by Brooklyn Botanic Garden taxonomist George Kalmbacher, who wrote the foreword.

Echeveria by Eric Walther. California Academy of Sciences, San Francisco. $15.00

Descriptions of 143 species.

Complete Book of Bulb Gardening by Frederic Doerflinger. Stackpole Books, Harrisburg, Pennsylvania. $12.95.

Corms, rhizomes and tubers, too. Enthusiastic account by one who has served as an information officer for the Dutch bulb industry. Intended for both American and British gardeners, the book gives much attention to varietal descriptions, little to growing bulbs under different geographical conditions.

Dwarf Rhododendrons by Peter A. Cox. Macmillan Publishing Company, Inc., New York, N.Y. $9.95

A top-notch report from England on their variety and uses.

Flowering Cherries by Geoffrey Chadbund. Collins Publishers, London. £2.85

Though subject to viruses and scale insects, this complex and varied tree group is one of horticulture's most valuable. In a posthumous book this English writer describes 68 kinds, with notes on other *Prunus* and suggestions on some evergreens as companion plants.

Regional

The Plants of Southern New Jersey by Witmer Stone. Quarterman Publications, Inc., Lawrence, Massachusetts. $25.00

Reprint of a 1911 botanical work.

Trees & Shrubs of Kentucky by Mary E. Wharton and Roger W. Barbour. University of Kentucky Press, Lexington. $12.95

A fine complement to the authors' 1971 volume, *A Guide to the Wildflowers & Ferns of Kentucky.*

The Trees of Long Island by George Peters. Long Island Horticultural Society, Planting Fields Arboretum, Oyster Bay, New York. Available from: Mr. and Mrs. C. A. Knapp, 225 Stony Hollow Rd., Greenlawn, N.Y. 11740. $2.25

Mainly because of its long horticultural history, this area has more big trees than its due. They are given special attention

here. A well researched account by a leading student of trees.

Wildflowers of Alabama and Adjoining States by Blanche E. Dean, Amy Mason and Joab L. Thomas. University of Alabama Press, University, Alabama. $10.00

Series

Deciduous Garden Trees and Shrubs, edited by Anthony Huxley. Macmillan Color Series. Macmillan Publishing Company, Inc., New York. $4.95

Also, in the series, with the same editor and price: *Evergreen Garden Trees and Shrubs.* Little books to carry along during visits to English gardens.

Flowering Trees and Shrubs in Color, edited by Francis B. Stark and Conrad B. Link. "Enjoy Your Garden" series. Doubleday & Company, Inc., Garden City, New York. $3.95

Others in this attractive series which originated in Italy: *Flowers in Color; House Plants in Color; Rock Gardens and Water Plants in Color.* Same editors, same price.

Gardening Without Stress and Strain by Jack Kramer. Charles Scribner's Sons, New York. $6.95 clothbound, $3.95 paperback.

Also put together by Mr. Kramer in the Scribner's series in 1973, with the same prices: *Grow Your Own Plants; Natural Gardens; Your First Garden.*

Vegetable Gardens, Culinary

All About Vegetables, edited by Walter L. Doty. Chevron Chemical Company, Ortho Division, San Francisco. $2.95

Separate editions for the South, West and Midwest-Northeast. Well done, without the usual sales pitch.

Gardening for Food by W. G. Smith. Charles Scribner's Sons, New York. Paperbound $2.45

Fruit and nut trees as well as vegetables.

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Spring: The Home Lawn Handbook *Summer:* Natural Plant Dyeing
Autumn: Broad-leaved Evergreens

Symbols: Sp (Spring, No. 1); Su (Summer, No. 2); A (Autumn, No. 3); W (Winter, No. 4)

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